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CRITICISM VS. ABUSE.

Our London contemporary, the "Electrical Review," in an editorial paragraph rather dictatorially and somewhat churlishly written, disposes of Dr. Pupin's method of long distance and submarine telephony and rapid telegraphy in a short leader, in which it is stated that the arrangement is old, is founded on fallacies, and instead of increasing working speed tends to do exactly the reverse; it further says that the question is not one of opinion but of stubborn fact, and predicts that a trial on an artificial cable would demonstrate that the system would not work. We will not discuss any question of fallacy or priority in the entire absence of any facts to support the charges made, but merely ask if our contemporary considers this method of criticism legitimate from any standpoint, scientific or otherwise. With all due consideration to its authority, it cannot expect in these days, when mere dicta, if even from Kelvins, are not accepted lacking demonstration, that such criticism can be considered legitimate. Dr. Pupin gives a very logical demonstration of the principles upon which the system so summarily criticised rests, and, however fallacious, they cannot be thus dismissed by mere assertions which, in the absence of any support, can justifiably be accepted as the mere expressions of prejudice. Such declarations belong in the same category with Lardner's declaration that ocean steamships were impossible, and with the Professor's condemnation of the principle of the incandescent lamp, and should be considered out of place in this day, when authority per se, even when as high as that of our esteemed contemporary, has little weight in the entire absence of facts to support it.

STORAGE BATTERIES.

We print elsewhere an abstract of the excellent paper by Mr. W. W. Griscom on storage batteries, read at the Philadelphia meeting of the American Institute of Electrical Engineers, which is one of the most useful contributions to the subject yet made. Important points brought out in the paper are that our knowledge of the chemical changes which occur in charge and discharge are still very incomplete, and that the internal conditions of the battery are constantly changing with reference to each other to a degree never heretofore suspected. That plates with precisely the same history and in precisely similar situations in a battery should give off currents varying as high as 30 per cent. is indeed singular, as is another fact mentioned, of neighboring plates presenting differences of potential to each other of .25 volt. Instead of the simple actions supposed to take place in storage batteries we learn that, on the contrary, every stage of charge and discharge presents different phenomena, and that local actions in a cell may assume very large proportions. The great diversity of opinion among professional electricians as to the commercial value of storage batteries is referred to, and rightly considered, we think, to be due entirely to whether experience was had with batteries worked beyond their actual capacity, on the one hand, or used well within it on the other. We cannot agree, however, with the conclusion that there is no necessity for changing the present rating in order to avoid the danger limit being continually approached, nor can we see the force of the argument that it is sufficient if a factor of safety is instead used. In all other branches of business a rating is supposed to be such that the thing to which it refers can be safely used at the capacity rated. A 50 h. p. steam engine means an engine that can be safely worked at 50 h. p., and there is always a margin on the

safe side, not the reverse, as with storage batteries. Those who have installed storage batteries know how difficult it is to keep a battery under ordinary circumstances from being overworked, and the difficulty there would be in inducing a purchaser to work it below the rate which entered into the price paid. It is very poor policy for a manufacturer to adhere to a rating when he knows that the consequence in very many cases will be failures of batteries of which he will have to bear the onus. To meet competition the nominal rating might be retained, but with the definite understanding that it is merely a nominal rating, and not to be confounded with another--the real rating of a battery for working purposes.

CENTRAL STATION STATISTICS.

In the Digest is an abstract from a recent paper on German central stations, which is particularly interesting in view of the data given in regard to storage batteries, which are now at last commencing to be adopted in this country for central station use. It will be seen that in four stations the machinery is run continuously at its highest capacity and in others with a load factor above .8. What this means is evident from a study of the recent report of the Massachusetts Board of Gas and Electric Light Commissioners, where apparently only two stations have load factors above .2. We may here remark that the Massachusetts report, admirable as it is, would have its value very largely enhanced if it included the load factors of the various stations and the annual output in kilowatt hours. Without one or both of these quantities some of the most valuable deductions from the otherwise very complete data can only be very roughly made. The large part which accumulators play in some of the German stations is also shown by other figures, the percentage of the total output taken from batteries being as high as 74.7 per cent., the lowest being 15 per cent. The efficiencies are not notable, except in their uniformity, the highest being 82 per cent. and the lowest 80. This is watt hour efficiency, of course, the ampere hour efficiency in any case showing little or nothing. The average price per kilowatt hour for electrical energy for lighting is very high, 18 cents, which is more than the usual charge in this country, but the average would probably be much less, as differential rate systems of charge are greatly in vogue on the Continent.

INDUCTANCE AND REACTANCE.

The London "Electrician" welcomes the two names, "inductance" and "reactance," adopted at the Philadelphia meeting of the American Institute of Electrical Engineers notwithstanding its expressed policy of disapproval of the multiplication of names of physical quantities. It refers to the doubt that has existed as to the meaning of the former term, some writers using it to express the coefficient of induction and others implying by it a quantity of which the coefficient of induction and current frequency are joint functions, and points out that the ambiguity has probably been due to the absence of a name for the latter quantity, which is now supplied by the term "reactance." This latter term is also pronounced a distinctly good one, "conveying, as it does, by contrast with 'resistance' the idea of an elastic reaction as opposed to an inelastic or power dissipating reaction." Now that our esteemed contemporary has relaxed its policy of opposition to the introduction of new names into electrical science, we trust that it will weigh carefully the advantages of the new names for the magnetic units before it puts up the bars again. In this connection we beg to call attention to the futility of the resistance that was encountered by some of the other names now so firmly fixed in electrical science, and to point out the weakness of opposition to a measure which, instead of being revolutionary, merely completes an accepted system of rational nomenclature. It will indeed be a losing battle fought against a measure with this recommendation and one which would introduce a simplicity well illustrated, for example, by the contrast of the expressions, "sixteen thousand C. G. S. lines of force per square centimetre" and "sixteen kilogausses."

UNDERWRITERS' ELECTRICAL INSPECTION.

We learn from a newspaper that the Hartford, Conn., city council, owing to some recent fires of mysterious origin, employed an electrical expert to make an inspection of electric light wiring in buildings of the city, who has reported defective wiring in no less than fifty-seven offices and stores in the business part of the city, including two large hotels, and the city, as a consequence, has taken steps toward having the defects corrected. Almost every building inspected was reported more or less lacking in the requirements for safe wiring. Assuming that the defects reported were real ones, and that the buildings in which they were present carried insurance, the question naturally arises, why was the wiring passed by the electrical insurance inspector? It is no small reflection on electrical insurance inspection if, notwithstanding the great money interest at stake by insurance companies, city governments are thus compelled to revise the work of underwriters' experts in order to protect the community from fire. The rules of the International Electric Association of Underwriters' Experts, which, we presume, are in force at Hartford, are certainly sufficiently rigorous, and we very much doubt if any city government would attempt to add to their severity. Some time ago we referred to what seemed to be the absurdity of having city inspectors of interior wiring in view of the great interest of underwriters to secure the most rigid inspection, but this comment apparently does not apply to Hartford. We also learn that in some cases local underwriters' associations modify, both by omissions and additions, the above set of rules notwithstanding the great care taken in their preparation. In view of the extended examination to which each of the clauses was subjected by a large number of competent experts, who also had the assistance of advice from recognized scientific authorities, the necessity of such revisions is questionable. In many instances they are probably due only to the human weakness of desiring the credit of superior knowledge, or are the result of personal idiosyncrasies which should have no place in a matter where so much is at stake. There would seem to be a necessity for a national body for the regulation of insurance inspection, supported by the insurance companies, to which the experts of the various underwriters' associations would be subject as far as the proper observance of rules was concerned, and whose general inspectors would have supervisory authority over local inspectors. Then all revisions thought necessary could be submitted to this general body, which, with the aid of its consulting scientists, would be more likely to arrive at correct conclusions than would individual local inspectors. While insurance inspection is in very much better shape than it was two years ago, there is yet abundant room for improvement along the lines indicated, and it does not seem that any further progress of importance can be made until authority is given to some central body over inspection rules, and, through its general inspectors, over local inspectors.

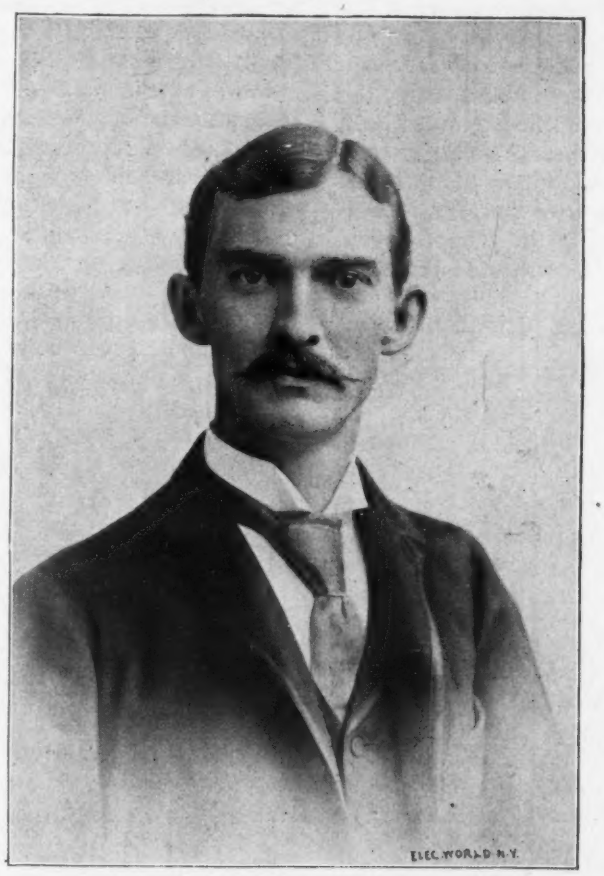
Indicating Primary and Secondary Circuits in Drawings.

Mr. Hospitalier suggests that a uniform system might be adopted to distinguish between primary and secondary circuits on drawings, by adopting a red color for the former and blue (or black) for the latter, and remembering the same by a sort of analogy with the arterial and venous blood circuits.

O. B. Shallenberger.

In any list of the half-dozen great electricians whose labors have done most to advance the United States to the pre-eminent position she now occupies in the field of practical electricity, the name of O. B. Shallenberger would unquestionably appear, yet his personality is perhaps less familiar to the general electrical public than that of very many of its lesser lights. Of a retiring disposition and singularly averse to publicity, he has been content with the personal recognition freely accorded by those whose appreciation is based upon direct knowledge of merit alone, being otherwise apparently satisfied with the consciousness of his great share in the remarkable technical achievements of the company with which his name is indissolubly connected.

Oliver Blackburn Shallenberger was born at Rochester, Pa., in 1860. In 1877, at the instance of his uncle, who was then a member of Congress from Pennsylvania, he entered the United States Naval Academy as a cadet engineer. From the commencement he took a leading position in his class, and even at this early date became known for the excellent judgment, which afterwards was such a large factor in his success. About this time Prof. N. M. Terry had begun to develop the excellent course in physics which has added so much to the reputation of the Naval Academy, and Mr. Shallenberger had no sooner entered upon that study than he began to take a special interest in the department of electricity. His inclination from the first was toward original and experimental work, and among other experimental apparatus he constructed at that time—1880—was a Maxim lamp. It may here be remarked that Mr. Shallenberger's course at the Naval Academy was contemporary with that of Duncan, Sprague, Hasson, Wilkes and several others whose names are well known among electricians. After his graduation in 1881, Mr. Shallenberger made a cruise in the Mediterranean, during which he was present at the bombardment of Alexandria; he returned to the United States in 1883 and resigned from the Naval service the following year in order to give his whole attention to electricity.



O. B. SHALLENBERGER.

In 1884 he became connected with the Union Switch and Signal Company, of Pittsburgh, as assistant in its newly organized electric light department. His abilities were at once apparent and the following summer he was selected to take charge of the setting up and operation of the Gaulard & Gibbs apparatus, imported from Europe by Mr. Westinghouse, at which time his practical acquaintance with alternating currents began. After Stanley's experiments at Great Barrington, Mass., and other experiments conducted at Pittsburgh by Mr. Shallenberger, the alternating current system was adopted, the Westinghouse company was organized and he was appointed chief electrician.

Mr. Shallenberger was one of the earliest to bring to bear upon the practical operation of alternating current systems of distribution the knowledge acquired by theoretical training. He manifested not only a clear comprehension of the theoretical and mathematical problems involved, but also a marked ability to practically design and proportion apparatus.

During the rapid development of the alternating current system that immediately followed its adoption, Mr. Shallenberger was responsible for the electrical design of all the apparatus, personally superintended tests, and designed, erected and operated the pioneer transformers at Lawrenceville, Pa., located four miles away from the generators. Later he designed a great part of the central station apparatus required for the system, such as compensating voltmeters, synchronizers, etc., and contributed a large share of ideas for the design of generators and transformers.

Early in the operation of alternating current machinery it was considered a difficult matter to couple alternators in parallel, and Mr. Shallenberger was the first in America who succeeded in doing this. In order to determine the relative position of the phases so that the machines might be coupled together when in synchronism, he devised an ingenious phase detector for indicating the relations of the phases of respective electromotive forces, and thus insure the coupling in parallel when the machines arrived in step with each other.

Among the most important of Mr. Shallenberger's numerous inventions is the system of operating incandescent lamps in series with a shunt of high self-induction around each lamp. This system is extensively used for street lighting. The most beautiful of his inventions is undoubtedly the electric meter, and the history of its development is a good illustration of the alertness of Mr. Shallenberger's mind in grasping and applying the laws governing electrical phenomena.

One day, while observing the operation of a newly devised alternating current lamp, a small spiral spring became detached from some portion of the mechanism and fell upon an extended flange or disc at the end of the main magnet of the lamp. By a fortunate coincidence, the structure of the lamp was such that the spiral spring rested in a position where it was under the influence not only of the lines of force proceeding directly from the magnet coil, but also of those from the end of an extended core of soft iron wires. Some one present was about to replace the spring in its proper position when Mr. Shallenberger noticed that it had assumed a slight rotation about its longitudinal axis. Being unable to account for this action upon any previously known laws he made a careful study of the phenomenon. For instance, he placed the spring in a small glass tube and held it in a similar position and found that its rotation was caused, not by any jar of the lamp, but by electrical or magnetic action. He immediately realized the applicability to the operation of a meter of the force thus discovered to underlie the movement of the spring, and then commenced a series of experiments which Mr. Shallenberger conducted in rapid succession, all aiming to produce the simplest form of motive device to be operated by and to measure alternating currents. Within three weeks from the original experiments with the arc lamp (April, 1888), he had produced the Shallenberger meter in practically the same form as it now exists, and of which more than 80,000 are now in operation.

After active work until 1891 Mr. Shallenberger was obliged to retire on account of ill-health, and spent a year in Colorado. During the past year, however, he has again taken up experimental work at his laboratory at Rochester, Pa., and is now consulting electrician to the Westinghouse Electrical and Manufacturing Company. The laboratory, where he now spends the majority of his time, is equipped with all the modern electrical apparatus required for careful tests and researches, and his time is largely devoted to investigations into the more advanced electrical problems. In addition to his purely technical work, Mr. Shallenberger has acted as expert upon electrical matters in a large number of patent cases.

That Fifty Thousand Dollar Prize.

In order to relieve itself of the odium connected with the recent sham electric railway competition of the Metropolitan Traction Company, the New York State Railroad Commission has issued a circular letter to competitors giving the correspondence leading to the withdrawal of the offer. In reply to an equivocal letter of the Traction company, the commissioners state their regret that the withdrawal of the offer had not been announced earlier. "Such notification," they say, "would have permitted the board to inform the public and the legislature of the abandonment of the offer, and it would seem in justice, particularly to the persons who have been induced by the publication of the offer to make application for permission to compete for the prize, that such notice should have been given."

The Berliner Patent.

Arguments were begun June 14 before Judge Carpenter in the United States Circuit Court at Boston in the suit of the United States Government to annul the Berliner patent of the American Bell Telephone Company. The bill of complaint states that Emil Berliner, of Germany, filed in the Patent Office at Washington on June 4, 1877, an application asking a grant of letters patent for certain improvements in combined telegraphs and telephones alleged in said application to be invented by him. The application rested in the Patent Office until Nov. 17, 1891, or about 14 years after the application was first filed, and the patent was granted on that day, but to the American Bell Telephone Company as assignee of Emil Berliner.

The United States contend that the Bell company controlled the Berliner patent during this period before the issuing of the letters patent, and that it made no attempt to secure the letters patent in that time, which was probably due to the fact that it was enjoying the privileges of the Bell patent, which controlled the electric transmission of speech. It is charged that the patent was unlawfully obtained and issued by the Commissioner of Patents, and is an illegal grant and ought to be annulled, for reasons, and further, as an act of duty and justice toward the citizens of the United States, whose rights and privileges are unlawfully and unjustly abridged by the Berliner patent.

Report on a Municipal Plant.

City Engineer Keating, of Toronto, Canada, has submitted an exhaustive report to the city council on the subject of street lighting, accompanied by data showing the cost of electric lighting in a large number of cities lighted by contract and in 18 cities lighted by works owned by the corporation, and the result of the inquiry is claimed to show that cities can do lighting much cheaper by owning the plant than by contract. From the report we abstract the following:

"Some of the reasons why municipal plants are able to show a smaller annual cost than those owned by private companies are as follows: 1. In the construction of a municipal station the municipality saves the profit that a private company would of course expect to make. 2. A city is generally in a position to borrow money at a lower rate of interest than a private company. 3. Most of the plants owned by private companies in the large cities were put in some years ago, when the cost of electrical appliances was greater than it is to-day, while their efficiency was less. 4. In the construction of a private plant capitalists will not risk investing money unless they are assured of receiving good dividends, while all that the municipality requires is a sufficient return to pay the cost of running, including interest on the outlay, with a margin for renewals.

"There is throughout the continent a strong tendency developing toward municipal ownership of street lighting. Detroit is now installing a first-class electric lighting plant of its own, under the control of a public lighting commission. Minneapolis is also moving in the same direction. I am now in communication with the Cataract Construction Company, of New York, regarding the transmission of power from Niagara Falls, but no definite offer has yet been made by the company. There appears to be a difference of opinion amongst electricians as to the feasibility of conveying power from this source such a distance to compete with the stream.

"During 1893 the city paid $135,243.17 for street and park lighting, of which sum $105,293.50 was for electric lights and the balance for gas lamps. We have now in the city of Toronto about 1,000 arc lights and 1,100 gas lamps distributed throughout the city for street lighting purposes. The estimate given below is for a plant of 1,300 arc lights of 2,000 c. p., burning all night and every night, the intention being to shut off and discontinue all or nearly all of the gas lamps. The capacity of the proposed station will be sufficient to run about 1,500 lights.

"The estimated cost of a plant for 1,300 lights is as follows: Buildings, etc., $42,000; engines and boilers, $60,000; dynamos, $40,000; poles, line and wires, $100,000; lamps, $40,000; add 10 per cent. for contingencies, $28,200; total cost, $310,000. This estimate is considered liberal, and I may say is largely in excess of the figures of those with whom I have corresponded. The estimated cost of operating this plant per annum is as follows: One chief engineer, $1,500; one electrician, $1,500; assistant engineers, $2,000; two dynamo tenders, $2,100; fifteen trimmers, $7,500; two inspectors, $1,600; two linemen, $1,200; one helper, $600; one driver, $500; one clerk, $800; one machinist, $700; keep of horse, etc., $175; coal, $39,420; carbons, $10,409; oil, waste, etc., $2,000; interest 4 per cent. and depreciations, 6 per cent., on $310,200, $31,020; total, $106,324. On the above basis the annual cost for 1,300 lamps would be $81.78 each, and for 1,500 lamps $75 each per annum; the city at present pays $108.58 per lamp per annum."

English Journalism.

A prominent and well known London technical journal, dated May, 1894, announces quite seriously that it has just received information to the effect that the electric railway has developed wonderfully in America! It adds, by way of explanation, that the electric railway is most extensively used for traction (!) in place of horses. We are glad to be assured of the fact that a railway is used most extensively for traction purposes, but we are curious to know for what other purposes it is sometimes used in England. We fear that this news item got shipwrecked in its transit across the ocean a number of years ago and has just been picked up by a stray vessel and transmitted to its destination, where it was published without the editor's knowledge. Or perhaps it is an English joke.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

The switchboard, in the generating house, is of the simplest nature, containing only low tension apparatus, such as the measuring instruments for the exciting current and main controlling switches for the generators and exciting machines.

Upon leaving the converters the high tension conductors are brought out through glass tubes having hard rubber mountings, and taken directly through the nearest window onto double-shed insulators, completely protected on the outside from birds or missiles, by the wire netting before mentioned. The disposition of these wires is such that no one can reach them without purposely climbing over the converter cases to do so. It speaks well for the design of this plant and the future operation of the system that up to the present no accident has occurred by which any one has received a serious shock.

Before the leading wires from the converters are directly connected to the line wires, which come into the netting at one end and run the length of the building outside, there is inserted a short length of thin silk-covered copper wire (about 2 feet of No. 24 B. & S. gauge) upon each of them. These lengths act both as safety fuses and lightning arresters. In case of the disruption of any of them, the attendant before replacing them telephones to the works, and the generators are temporarily shut down during the few minutes the operator requires. The two converters in use are connected onto the line wires in parallel.

The line consists of four bare copper wires, each four millimetres in diameter (equivalent to No. 8 B. & S.) Only three of these conductors are used, the others being held in reserve. The line has a total length from station to works of 24 kilometres, that is, 15.35 miles.

In the construction of the line, consideration was given to the desirability of having as few points of support as possible, so that the spans are often 100 metres (110 yards) long.

About every fourth pole is provided with a ground plate and a wire which passes up the side so as to act as a lightning conductor rod.

Although breakdowns on such a long length of line do occur, hitherto they have been unimportant as regards the satisfactory and continuous working of the plant. Upon the same posts, at an average distance of 2 feet 6 inches, below the four line conductors, two telephone wires are run.

The arrangement of the line where it crosses a public highway is interesting, an auxiliary guard wire netting being placed under the conductors, so that, in case of breakage, it is impossible for the ends to fall within reach of passers-by. On one or two occasions the high tension current has got onto the telephone wires, but no damage beyond the fusing of the ends or safety lengths has resulted.

The generator attendant has instant warning of the trouble by the extra "buzz" of his converters. He is amusingly graphic in his description of this method of recognizing the occurrence of a "fault." Several fatalities have occurred in Switzerland from the telephone wires being on the same

60 H. P. AND 3 H. P. THREE-PHASED MOTORS.

posts, but in every case it has been where they were placed above the line conductors. The recognized practice now is to place them below.

Where the line has to cross a railway track the practice has hitherto been to insert a length of underground cable, but owing to the trouble at these points, the railway companies now recognize the necessity of their being continued overhead, ordering, perhaps, the erection of an iron work supporting frame to obtain solidity.

In connection with recent discussions on alternating current transmission, it is interesting to note that this line is provided with an ample circular mileage cross-section, for with an average potential of 13,000 volts and a load approximating 340 kw. the loss in transmission is only about 2 1-2 per cent.

The high pressure current is received at the Oerlikon end in a similar way to that in which it leaves the generating sta-

tion, the converter arrangements being duplicated, but the ratio of retransformation is different, the shop system being supplied at 190 volts.

Distributed throughout this large establishment there are 40 motors, varying in capacity from 3 to 80 h. p. and running at speeds from 2,000 to 500 revolutions per minute.

A continuous current man can hardly fail to be "converted" into an alternating one when he examines and watches the operation of these motors, which, without commutator or brushes and minus a comparatively huge starting box, do every kind of work required of them in a machine shop, running perfectly without even the usual minimum of attention.

A 60-h. p. standard motor, with eight poles, which runs at 750 revolutions, is shown herewith. These figures are given upon the basis of 50 cycles per second and are the speeds of the armature when running light; it is estimated that on full load there is a "slip" of 4 per cent.

A 3-h. p. standard motor is also shown, which has four poles and runs at 1,500 revolutions; for those applications where slower speed is desired, it can be designed with 6, 8, 10 or even 12 poles, when the speed will become 1,000, 750, 600 or 500 revolutions, respectively.

Interior views of the shops are given below, illustrating the practice of placing the smaller motors on bracket supports built into the wall. In this way floor space is economized and both motor and belting placed out of reach of the workman, either for accident or experiment. In Fig. 6 the motor in the foreground is one of 6-h. p. capacity, has six poles and runs at 1,000 revolutions. The simplicity of the wiring and starting arrangements is evident; all that is required is a three-pole switch fitted with safety fuses.

The motor will start from rest, with or without load, gaining its proper speed some 20 or 30 seconds after the switch blades have been thrown in.

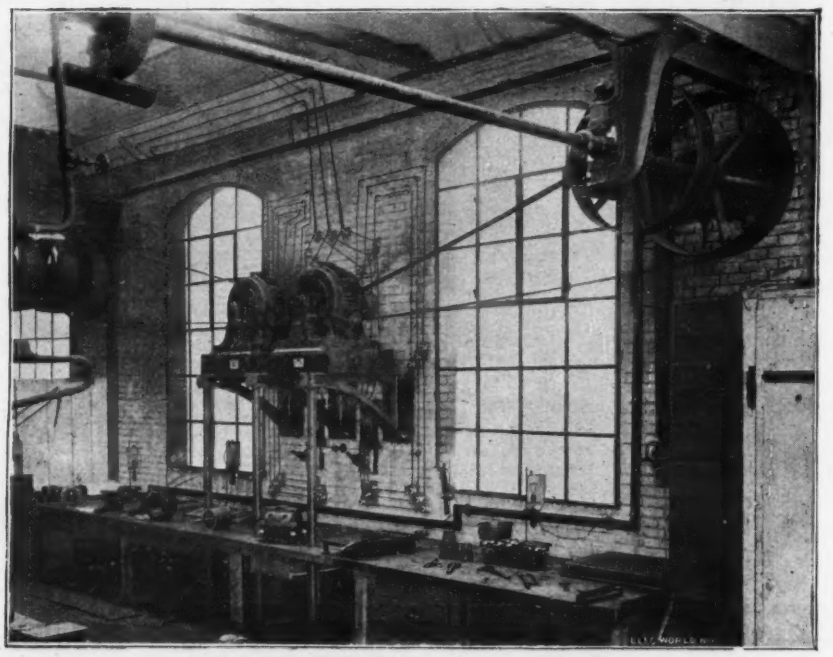
One of the cuts shows two 12-h. p. motors having six poles and running at 1,000 revolutions. They are arranged above a fitting bench and the same simplicity of controlling arrangements is apparent.

In some instances, depending upon the size of the generating plant and the capacity of the individual units employed, special starting arrangements are made, either by the insertion of a resistance in the armature circuit, which, when starting up, is cut out in the ordinary way, or by the intervention of special or extra converters, in which the number of active coils in the secondary circuit can be adjusted to the speed of the motor. By these arrangements the armatures are protected from excessive currents and from disturbing the remainder of the circuit. All these motors can be overloaded as much as 50 per cent. without mishap, and the speed with such overload does not drop more than 10 per cent. Power for power, they are individually lighter than continuous current machines, occupy less space and present less chance for electrical or mechanical injury.

It is perhaps the cut which illustrates one of the 10-ton shop cranes, which more than any of the others brings home the conclusion that this system is eminently suited to the requirements of factory work. These cranes are fitted with three motors, two of 3-h. p. capacity for the traversing and the cross travel of the trolley carriage, respectively, the others of 9-h. p. capacity for hoisting. The movements actuated by the two small motors are controlled without any other apparatus except a double headed three-pole switch, the blades being thrown either to one side or the other, as "forward" or "reverse" is required. The 9-h. p. motor has a simple form of iron feed resistance box with six contacts. This is small and compact, and can be seen in the cage.

This crane, as operated by three-phased motors and the screw gearing of the Oerlikon pattern, is probably unique in its simplicity of construction and operation.

The first cost of shop tools of this nature will now no longer be the factor militating against their adoption in any machine shop of any pretension.



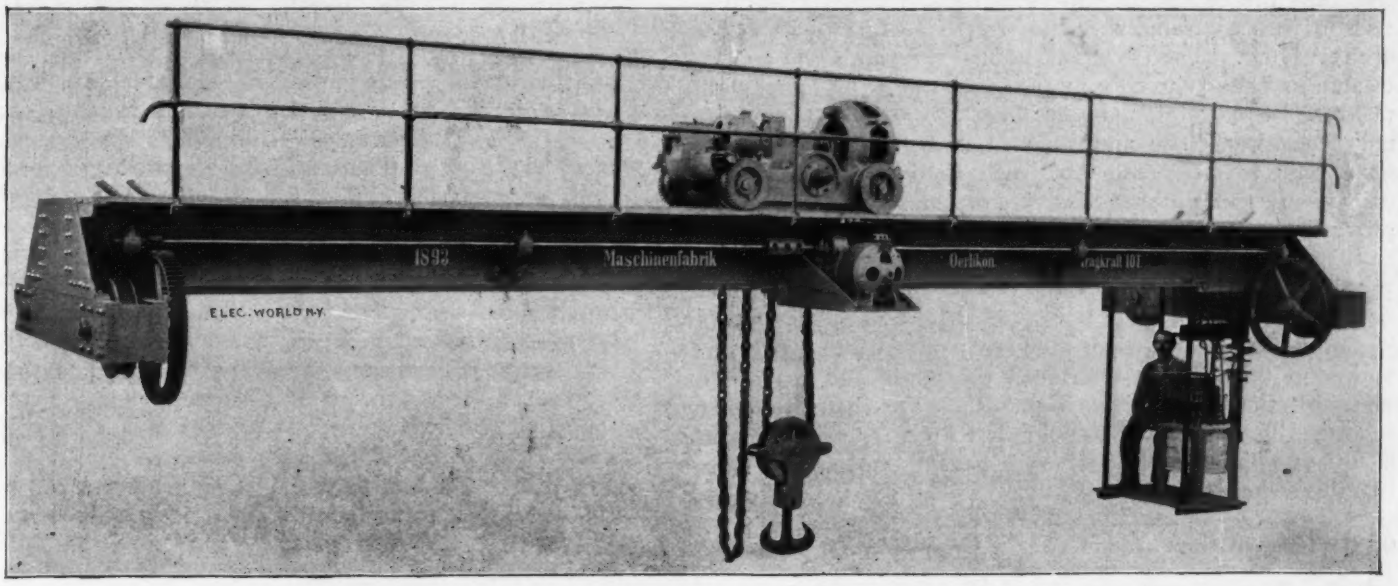
INTERIOR VIEWS OF SHOPS SHOWING BRACKET MOTORS.

The last view indicates that the Oerlikon works have long passed the experimental stage in the manufacture of machines for this system. It represents the frame and stationary armature of a 300-h. p. generator, which is to generate 5,000 volts when running at a speed of 250 revolutions. The machine is designed for use in a steam power plant, the usual form for turbine driving in a water power plant being horizontal.

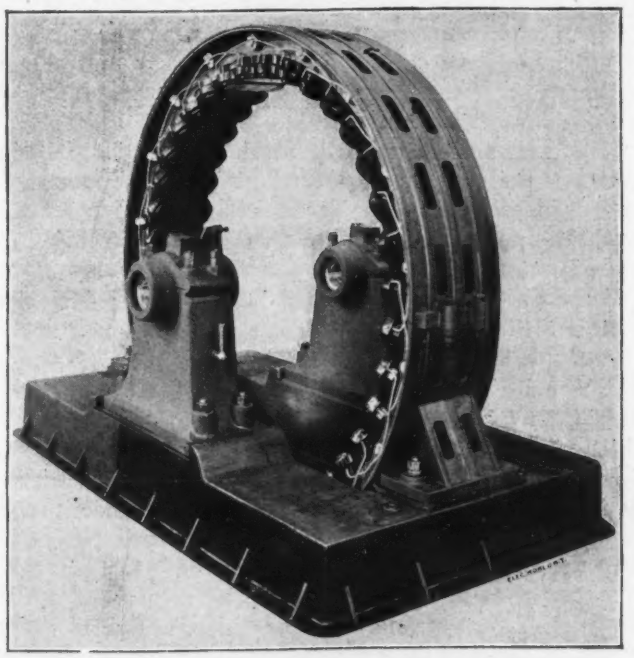
Those who have seen this installation and distribution of power must conclude that the three-phased system can immediately compete with a continuous current distribution, weight for weight of material employed, and have many advantages in application, and particularly in long distance transmissions, and prove safer and more economical.

The motors are simpler, mechanically and electrically, cheaper and more compact, and never burning out, prove positively reliable.

To Mr. C. E. Brown, who is now concentrating his attention on the two-phase system, must be given the credit for the first commercial development of this installation, but he has been equally ably seconded in his pioneer work by Messrs. Huber and Kolber, who have effected the important work of standardizing types and sizes, so that the system can be placed on the market, but whether it is a two or a three phased system, those who have seen the recent developments in Switzerland will admit that they are here finding an application that has no comparison in any other country.



SHOP CRANE OPERATED BY THREE-PHASED MOTORS.



FRAME OF 300 H. P. THREE-PHASED GENERATOR.

A New Definition of a Dynamo.

According to a London contemporary a reporter asked whether a dynamo was not a kind of reservoir and was told that "it was a kind of boiling tank to keep the electricity hot."

Measurement of Phase Difference.

BY W. STUART-SMITH.

In The Electrical World of Feb. 10, 1894, I explained the principles of an instrument for giving the phase angle between a current and its E. M. F., and at the same time showing the shape of the two waves. At the close of the article I mentioned another instrument for showing the phase angle only, but did not state the principle involved, because I considered it would have a commercial value, and I intended taking out a patent for it.

The principle involved is that of showing the angular difference in position between two shafts revolving at the same speed, and as the paper read by Dr. Bedell at the annual meeting of the Institute of Electrical Engineers at Philadelphia shows that this principle is being considered, I give here a description of the instrument as I intended it to be made for use in central stations and generally where the phase angle is desired for practical reasons. I described the instrument verbally to Mr. William Rosenbaum last February.

One form is as follows: Two small motors would be set in line with each other, one having a hollow shaft, through which passes the shaft of the other, the two being concentric. The motors would have field magnets symmetrical in all parts so that if the entire machine was revolved there would be no tendency to vibration. One of the motors would be in the main circuit and run in synchronism with the current, and the other would be connected across the circuit and run in synchronism with the E. M. F. Each shaft would be provided with a slight stiff hand and one of the shafts would also carry a disc which would be graduated in degrees, a greater or smaller portion of the circumference representing 360 degrees, depending upon the number of poles in the motors. Both motors would, of course, have the same number of poles.

Both hands being against a stop, and consequently the reading of the scale being zero, if switches be closed, putting the two motors in their respective circuits, they will soon come into synchronism, one with the current and the other with the E. M. F., and the hands will take up positions making an angle with each other which is the angle of effective phase difference. This angle cannot be read, however, as the hands are revolving at high speed, but a simple clutch can be arranged to secure them in their relative positions and the switches being opened and the motors stopped the angle can be read off the scale. Or, otherwise,

let a brass casing be placed over both motors and secured to the two fields; a spider will enable this casing with its enclosed motors to be secured to the shaft of a third small motor set to run in a direction opposite to the first two. Now, when the first two are running and have settled into their respective positions, if the third motor be started it will turn the casing, motors, dial, etc., in the opposite direction with the same speed at which the first two motors are revolving. The effect will be that the hands will appear to stand still and the only motion seen will be an increase or decrease of the angle between them as the load on the dynamo changes. The motors can be small, as the first two have only to overcome their own friction, and the third can be any small motor revolving at the same speed as the other two.

Instead of the motors being on the concentric shafts they can be separate and be connected to the shafts by bevel or other gearing. There being no angle between the shafts start the motors and when they have settled into synchronism with their respective circuits lock the shafts together and stop the motors, then read the angle and make the record. This would be the simplest form for station work, and the reading could be taken in a few moments after closing the switches.

On the Measurement of the Power of Polyphased Currents—III.

BY ALEXANDER D. LUNT.

Framing this expression in words, it may be said that the mean power expended in a polyphased system is represented by the summation of a series of quantities, each found by obtaining the mean product of the current in each line conductor by the difference of potential between the terminal of that conductor and the terminal of some one conductor nominally selected as a standard. Thus, in a system of n line wires there will be $n-1$ such products necessary to represent the mean power. In order to obtain the mean expended in the system, it is only necessary to ascertain the mean value of each of the separate products by the use of an electro-dynamometer or any other means of measuring the mean power of a simple alternating current, as will be referred to later.

It will thus be seen that the power of a polyphased cur-

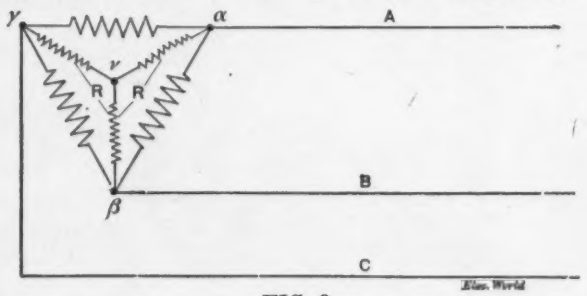


FIG. 3.

rent is not such a complex quantity as might at first be thought.

Hitherto the above result has been reached either in a less natural way, or on assumptions based on the form of the circuit in which the energy is utilized.

The above expressions may easily be transformed so as to correspond with formulae given by other writers. Thus, adding (3), (4), and (5),

$$3\rho = A(\alpha-\gamma+\alpha-\beta)+B(\beta-\gamma+\beta-\alpha)+C(\gamma-\alpha+\gamma-\beta), \quad (6)$$
$$= A[3\alpha-(\alpha+\beta+\gamma)]+B[3\beta-(\alpha+\beta+\gamma)]+C[3\gamma-(\alpha+\beta+\gamma)]$$

whence

$$\rho = A\left(\alpha-\frac{\alpha+\beta+\gamma}{3}\right)+B\left(\beta-\frac{\alpha+\beta+\gamma}{3}\right)+C\left(\gamma-\frac{\alpha+\beta+\gamma}{3}\right)$$

a formula identical with that derived by M. Blondel.* In the application of this formula it is necessary to make such connections between the terminals as to produce at some point on those connections an intermediate point having a potential $\frac{\alpha+\beta+\gamma}{3}$. This may be done by joining the terminals through equal resistances R, which preferably should be large and as nearly non-inductive as possible. The connections are shown diagrammatically in Fig. 3. Call

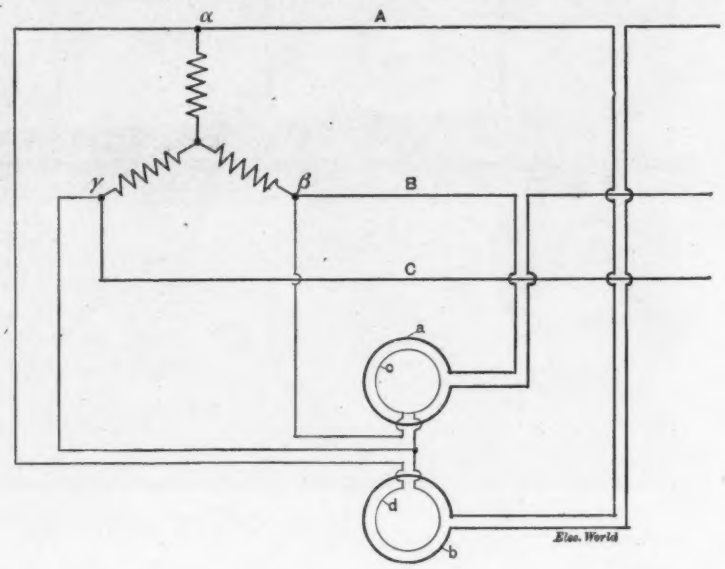


FIG. 4.

the potential of this junction v. Then from the principle of continuity it is evident that

$$\frac{v-\alpha}{R}+\frac{v-\beta}{R}+\frac{v-\gamma}{R}=0,$$

whence

$$v=\frac{\alpha+\beta+\gamma}{3}.$$

Hence, by this method the mean power of a polyphased system is the sum of the several integrated products of the current in each line wire by the difference of potential between the point v and the terminal corresponding to the line wire.

If the differences of potential between the principal conductors or line wires be denoted by Δ_α, Δ_β, Δ_γ, such that

$$\Delta_\alpha=\alpha-\beta,\quad \Delta_\beta=\beta-\gamma \text{ and } \Delta_\gamma=\gamma-\alpha,$$

then by substitution in (6) it follows that

$$\rho=\tfrac{1}{3}[A(\Delta_\alpha-\Delta_\gamma)+B(\Delta_\beta-\Delta_\alpha)+C(\Delta_\gamma-\Delta_\beta)]$$

which is identical with a formula deduced by Herr Georges.** It is, however, much more inconvenient to use than either of the equations indicated above, since it requires six measurements to be made instead of either two or three.

In the two methods last indicated the mean power is to be obtained as in the first method, by measuring the mean products of current and difference of potential, as indicated by the relations of the instantaneous values expressed by the equations for the instantaneous values for power.

All of the above methods are general and are perfectly applicable to practical measurements, and do not depend on the form of the circuit in which the energy is expended, and, as will be noted, are not coupled with any restrictive hypothesis.

It will be observed that in obtaining the above formulae no account whatever was taken of the manner in which the terminals of the line wires might be connected, the derivation being concerned only with the number of line conductors and the respective potentials at the terminals of those conductors. Since two and three phased systems each in general

* "Lumiere Electrique," Jan. 21, 1893, page 139.
** "Elektrotechnische Zeitschrift," 1891, page 212.

employ three line wires, it thus becomes apparent that the mean power of each system may be measured in identically the same manner, so that in either case, given the three line wires and the three terminals, the measurement may be carried out irrespective of the connections between those terminals and with entire disregard as to whether a two or a three phased system is being dealt with.

In carrying out the measurements in practice any of the usual methods of measuring the mean power of variable or alternating currents may be employed in making the separate measurements. The ordinary alternating current wattmeter furnishes probably the most convenient and perhaps the most accurate means for this purpose. The instrument should be constructed with as little self-induction as possible in the series coil, as well as in the so-called fine wire coil. If the impedance of the series coil be negligible, it will not then be necessary, when the said coil is introduced into one of the line wires, to likewise introduce a coil of equal impedance into the other line wires, as would otherwise be necessary for the purpose of preserving the symmetry of the system and preventing a redistribution of the currents therein.

Likewise, if the fine wire coil be of such character as to permit a non-negligible current to pass, then, as before, precautions must be taken to prevent any change in the distribution of the currents when this coil is connected in place, and this may be done by placing similar coils in like manner between the other conductors. Other precautions necessary in particular cases will readily suggest themselves.

In place of the ordinary wattmeter used in making the separate readings, one may employ instruments especially constructed to reduce the number of readings necessary. Such an instrument may consist of a mechanical combination of a number of wattmeters in such a manner that the readings of all the wattmeters are added together and appear as a single reading of the combination wattmeter. This result may be accomplished by placing the required number of movable coils rigidly secured together on a single axis, but free to turn about the common axis, and with the corresponding fixed coils secured in proper relation therewith. There should, of course, be no mutual induction between any of the coils. The turning moments due to the several pairs of fixed and movable coils may thus be added together, and in this manner the number of readings required in measuring the power of a polyphased current may always be reduced to unity.

The application of such a dynamometer to the measurement of the power of a three-phased current is illustrated in Fig. 4, wherein *a* and *b* are fixed coils and *c* and *d* the corresponding movable coils. The movable coils are so connected as to produce a turning moment in the same direction about their common axis. The turning moment thus produced may be measured by any suitable means, such as the usual spring and dial of the ordinary Siemens dynamometer. After calibration of the instrument the reading thus obtained gives at once the value required. The power of a polyphased current may thus be measured by a single reading.

Diseased Germs Transmitted Through Telephone Circuits.

That diseased germs are deposited on the mouthpieces of microphones and are thereby conveyed to other persons using the same instruments is an old and well-known fact, but the editor of a prominent Philadelphia daily, who has a dangerously small amount of knowledge about electricity, puts new life into this statement by explaining to the public that even diseased germs are now transmitted over telephone circuits, and he warns the public not to converse by telephone with any person having a contagious disease.

A Method for Measuring Telephonic Currents and Electromotive Forces.

BY HARRIS J. RYAN.

In some investigations that have recently been undertaken in the laboratories of Sibley College, at Cornell, I have employed the following method for the measurement of telephonic currents and E. M. Fs. Reference is made to the accompanying diagram, in Fig. 1. A modified form of dynamometer is used. The swinging coil is wound with from 50 to 100 turns of fine wire, through which the telephonic current is passed. About the swinging coil a strong alternating field in unison with the telephonic current is produced by passing a suitable alternating current through the field coil, with regard to which more will be said later on. The zero method is used for measuring the forces exerted on the swinging coil. The zero position of the coil is taken, so that it receives no induction from the powerful alternating field in which it is placed. A D'Arsonval galvanometer is so mounted and arranged that its coil may be rigidly attached

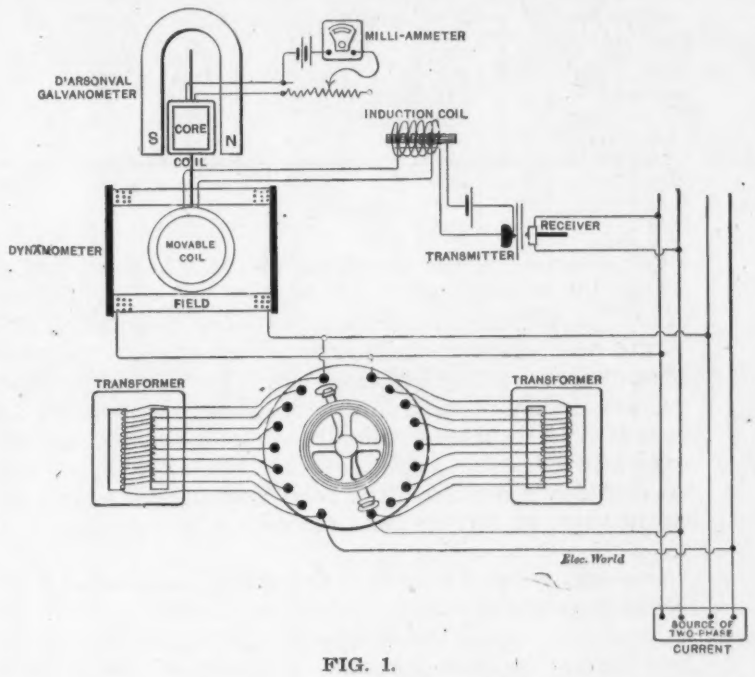


FIG. 1.

to the swinging coil of the dynamometer. Direct currents are established through the D'Arsonval coil in such a direction as to set up a moment that is opposite that produced by the telephonic current in the coil of the dynamometer. When the dynamometer coil is thus brought back to zero, the current through the D'Arsonval coil is taken as a measurement by calibration of the telephonic current, and is read on the Weston instrument.

In order that the field coil of the dynamometer may be brought into unison with the telephonic current, the note sounded in front of the transmitter is produced by one of the currents from a two-phase alternator. The current through the field coil of the dynamometer is delivered from a special two-phase transformer that affords the delivery of any desired phase. Those who have read Mr. Scott's recent valuable paper before the National Electric Light Association will understand readily the principles of operation of this transformer. Two coils that are surrounded by closed magnetic circuits of laminated iron are connected to the two-phase circuits of the alternator, as indicated in the diagram. From the turns of these coils taps are taken off at proper intervals, and led to respective points on the contact switch. The contact switch enables one, by turning the hand wheel, to connect in series certain amounts of E. M. F. from one of the phases with desired amounts of E. M. F. from the other. These amounts are chosen so as to maintain the resultant

E. M. F. constant in amount but differing in phase by about five degrees from point to point on the contact switch. The diagram in Fig. 2 illustrates a graphic method for obtaining the interval values of E. M. F. that should occur between the contacts on the switch, so as to obtain a constant resultant E. M. F., whose phase position is uniformly changed from contact to contact. When the interval amounts of E. M. F. cannot be obtained by the use of complete turns in

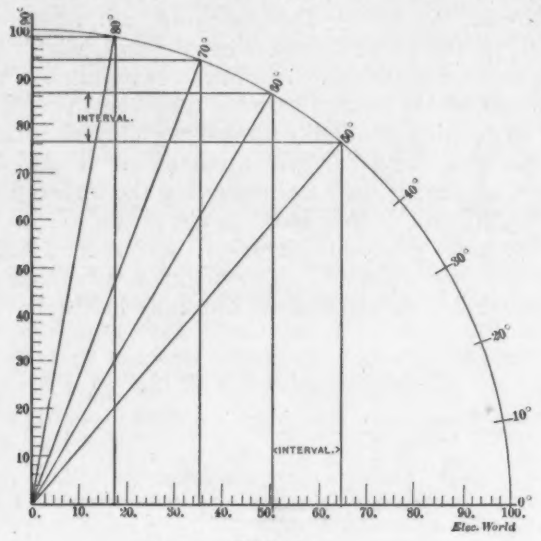


FIG. 2.

the transformer, the loops are taken out at a point that is nearest the required point, and on their way to the contact switch are led around a smaller auxiliary magnetic circuit excited by a primary winding that is subjected to the same phase pressure as the coil from which the loop is brought. Such an auxiliary electromagnetic circuit is provided for each of the two phases. The turns of the primary and the cross-section of the magnetic circuit are so designed that the E. M. F. generated in five turns will be equal to that developed by one turn in the main coils, which is about one volt.

One recognizes promptly when the field current of the dynamometer is in unison with the transmitter current in the moving coil, since at this point a change of the phase of the field current in either direction will diminish the moment tending to turn the suspended coil.

The calibration of such a measuring apparatus is made with Weston direct current instruments in an obvious and simple manner. A voltmeter is used for measuring the current through the suspended coil.

Spirals of annealed silver foil, arranged according to Mr. Weston's well-known method, are used for leading the small currents into the suspended dynamometer coil and the D'Arsonval galvanometer coil.

The same method is readily adapted to the measurement of telephonic E .M. Fs. Other methods can be employed for shifting the phase of the field coil current, but the above method we have thus far found to be the simplest and best.

Electric Nomenclature and Terms.

According to a French journal, Mr. Hospitalier, the leading French advocate of definite and universal electric terms, is announced to give a lecture on "Polymorphiques" transformers and generators, by which term is probably meant those machines which generate or transform different kinds of currents.

A Profitable Business.

At a recent meeting of the Institute in Philadelphia one of the members was heard to remark to another that to be both a consulting electrical engineer and a contractor was like being both a doctor and an undertaker.

Magnetic Formulæ.

BY REGINALD A. FESSENDEN.

In a recent issue of The Electrical World the statement was made that the relation expressed by the formula $\lambda = a + b\,\mathfrak{H}$ (where λ is the ferric reluctivity or $\frac{\mathfrak{H}}{\mathfrak{B} - \mathfrak{H}}$) is not a physical law, but merely an empirical statement.

It is undoubtedly true that Mr. Kennelly may have hesitated to put this formula forward as a physical law, in spite of the fact that all experiments made to test this rule have only the more firmly proved its correctness.

In the opinion of the writer, expressed at various times during the last two years, this formula is not only the expression of a physical law, but it is the only definite magnetic law expressing a relation between the quantities which enter into the formula for the flux in a ferric circuit, of which we are sure; and it is also believed that it is to the development of this law that we must look for any satisfactory quantitive law of magnetization.

This is for the following reasons:

1. It holds, within the limits of experimental accuracy, and with pure iron, between the limits of $\mathfrak{H} = 1$ or 1 1-2 to $\mathfrak{H} = 150$, and probably higher. It holds for iron, nicke and cobalt. It holds, with the slight modification necessary, for the hysteresis curve of soft irons. It, therefore, stands upon the same kind of ground as Newton's laws of motion, whose only proof is that they hold in all cases where they have been tested, but in regard to whose physical meaning we are absolutely ignorant.

2. It can readily be thrown into a form in which it is analogous to the expressions connecting the relation between stress and strain in a great number of other cases.

This is best seen by expressing the ferric reluctivity, λ, in terms of the ferric induction, $F\ (= \mathfrak{B} - \mathfrak{H})$.

We have

$$\lambda = a + b\,\mathfrak{H}. \qquad (1)$$

Therefore, since $F = \mathfrak{H}/\lambda$

$$\mathfrak{H} = a\,F + b\,F\mathfrak{H}. \qquad (2)$$

Substituting for $\mathfrak{H}$ in the right hand member, its value as given in (2), we get $\mathfrak{H} = a\,F + a\,b\,F^2 + b^2\,F^2\,\mathfrak{H}$.

Continuing this process, we get

$$\mathfrak{H} = a\,F + a\,b\,F^2 + a\,b^2\,F^3 + a\,b^3\,F^4 + \ . \ . \ .$$
$$+ a\,b^{n+1}F^{n+1}\mathfrak{H} = a\,F(1 + b\,F + b^2\,F^2 + b^3\,F^3 + b^4\,F^4 + \ . \ . \ . \ + b^n\,F^n\,\mathfrak{H}).$$

This series is convergent for all values of $\mathfrak{B}$, for, since $F = \mathfrak{H}/\lambda = \mathfrak{H} / (a + b\ \mathfrak{H})$, it is evident that $b\ F$ is always less than unity (except, of course, when a is zero, as Mr. Kennelly has shown it is in the case of nickel stretched by a certain weight, when $\lambda = b\ \mathfrak{H}$).

(It is also easily shown that the last term, $b^n\ F^n\ \mathfrak{H} / a$ is negligible.)

Therefore,

$$\mathfrak{H} = a\,F \sum_0^\infty b\,F^n,$$

or dividing both sides by F

$$\lambda = a \sum_0^\infty b\,F^n.$$

This expression is of a type very commonly met with in physical problems, and it means simply that, when any given induction has been attained, that the magnetic resistance is proportional to the zero, first, second, third, etc., powers of that induction.

This is an extremely simple law. The writer has not attempted, as yet, to work out a theory which should give this law, but at first sight it would appear comparatively a simple matter. We know, from the various modified forms of Van der Waal's equation, and from the experiments of Pictet, Amagat, and others, and the work of Tait and other physicists, that the distance between the surfaces of two adjoining iron atoms is on the average 20 to 50 per cent. of the diameter of the atoms themselves. We may also suppose, with

Prof. Fitzgerald and others, that the magnetism of the iron atoms is due to a current circulating in a non-resistant path round the atom. We know approximately the sizes of the atoms, the magnetic moment of an atom, and, therefore, the quantity of electricity circulating on the atom. Therefore, the problem becomes: Having given the distances, dimensions, current fluxes, etc., as above, to show that, when a steady state is set up, that if a certain number of atoms be turned (as in Prof. Ewing's theory), that the reluctance is proportional to the series of the powers of the induction produced.

3. The beautiful simplicity it introduces into all magnetic calculations where the permeability varies with the induction. Mr. Kennelly has already indicated its uses in dynamo calculations, but there are a number of derived formulae which have great use.

Take, for instance, Mr. Carichoff's paper on the design of electromagnets. Here we have to make $\frac{d\mathfrak{H}}{d\mathfrak{B}}$ in the air gap equal to $\frac{d\mathfrak{H}}{d\mathfrak{B}}$ in the iron. By the use of the formula, we can write at once, $d\mathfrak{H} / d\mathfrak{B} = \frac{a}{\lambda^n} = a / (a + b\ \mathfrak{H})^2$, and so solve the problem immediately, without making any drawing. This equation is got from the equation $\mathfrak{B} = \mathfrak{H} / (a + b\,\mathfrak{H})$, by differentiation, and is of use in other problems.

It is for the above reasons that the writer believes the formula $\lambda = a + b\,\mathfrak{H}$ to be a physical law, and not an empirical relation, and to be the fundamental law of ferromagnetism.

Practical Notes on Dynamo Calculation—VI.

BY ALFRED E. WIENER.

14.—*Weight of Armature Winding.*

A copper wire of 1 circular mil $\left(= \frac{1}{1,000,000} \times \frac{\pi}{4}\text{ sq. in.}\right)$ area weighs .00000303 pound per foot of length; our armature conductor of δ^2_a circular mils sectional area, therefore, has a weight per foot of .00000303 $\times\ \delta^2_a$ pound. And the total L_t feet of it, used in winding the armature, will weigh:

$$lb._a = .00000303 \times \delta^2_a \times L_t\ ; \qquad (28)$$

$lb._a$ = weight of bare armature winding, in pounds;

δ^2_a = sectional area of armature conductor, in circular mils, from formula (4);

L_t = total length of armature conductor, in feet, formulæ (19) to (27), respectively.

In case of round gauge wires, the product .00000303 $\times$ δ^2_a is contained in the gauge table under the heading "lbs. per foot," and consequently the bare weight of the winding is found by simply multiplying the respective table-value by the total length, L_t, and, eventually, by the number of wires, p, stranded in parallel.

If, in case of heavy rectangular or wedge-shaped armature bars, the cross-section, δ^2_a, is given in square inches, the numerical constant in the above formula (28) should be replaced by 3.858, this being the weight per foot of a copper bar of 1 square inch sectional area.

When standard gauge wire is to be employed in winding the armature, it is desirable to know the weight of the winding, including its covering, particularly in the case when insulated wire, such as is obtainable from wire manufacturers, is to be used. This covered weight of the winding can be expressed as a multiple of the bare weight, by the equation:

$$lb._a = k_s \times lb_a = .00000303 \times k_s \times \delta^2_a \times L_t \qquad (29)$$

in which k_s is a constant depending upon the ratio of the bare diameter of the wire to the thickness of its insulation. In the following Table XXI. these ratios and the corresponding values of k_s are given for all standard gauge wires likely to be used for winding armatures, for single and for double cotton covering:

TABLE XXI.—WEIGHT OF INSULATION ON ROUND COPPER WIRE.

Gauge of Wire.		Diam. of Wire (bare) inches.	Single Cotton Insulation.				Double Cotton Insulation.			
B.W.G.	B. & S.		Thickness of insulation inches.	Ratio of bare diam. to thickn. of insul.	Weight of insulation in per cent. of co'd wire	Weight of cov'd wire per lb. of bare. k_s	Thickness of insulation, inch.	Ratio of bare diam. to thickn. of insul.	Weight of insulation in per cent. of co'd wire	Weight of cov'd wire per lb. of bare. k_s
1	—	.300	——	——	——	——	.020	15	2.28	1.0228
—	1	.289	——	——	——	——	.020	14.45	2.32	1.0232
2	—	.284	——	——	——	——	.020	14.2	2.33	1.0233
3	—	.259	——	——	——	——	.020	12.95	2.40	1.024
—	2	.258	——	——	——	——	.020	12.9	2.40	1.024
4	—	.238	——	——	——	——	.020	11.9	2.50	1.025
—	3	.229	——	——	——	——	.020	11.45	2.55	1.0255
5	—	.220	——	——	——	——	.020	11	2.65	1.0265
—	4	.204	.012	17	2.20	1.022	.020	10.2	2.85	1.0285
6	—	.203	.012	16.9	2.20	1.022	.020	10.15	2.86	1.0286
—	5	.182	.012	15.15	2.27	1.0227	.018	10.1	2.87	1.0287
7	—	.180	.012	15	2.28	1.0228	.018	10	2.90	1.029
8	—	.165	.012	13.75	2.33	1.0233	.018	9.17	3.20	1.032
—	6	.162	.010	16.2	2.24	1.0224	.018	9	3.25	1.0325
9	—	.148	.010	14.8	2.30	1.023	.016	9.25	3.15	1.0315
—	7	.144	.010	14.4	2.32	1.0232	.016	9	3.25	1.0325
10	—	.134	.010	13.4	2.36	1.0236	.016	8.4	3.55	1.0355
—	8	.1285	.010	12.85	2.40	1.024	.016	8	3.75	1.0375
11	—	.120	.010	12	2.50	1.025	.016	7.5	4.10	1.041
—	9	.1144	.010	11.4	2.55	1.0255	.016	7.1	4.35	1.0435
12	—	.109	.010	10.9	2.66	1.0266	.016	6.8	4.60	1.046
—	10	.102	.010	10.2	2.85	1.0285	.016	6.4	5.00	1.05
13	—	.095	.010	9.5	3.10	1.031	.016	5.9	5.55	1.0555
—	11	.091	.010	9.1	3.25	1.0325	.016	5.7	5.85	1.0585
14	—	.083	.007	12	2.50	1.025	.016	5.2	6.60	1.066
—	12	.081	.007	11.6	2.54	1.0254	.016	5.1	6.80	1.068
15	13	.072	.007	10.3	2.80	1.028	.016	4.5	7.80	1.078
16	—	.065	.007	9.3	3.15	1.0315	.016	4.1	8.60	1.086
—	14	.064	.007	9.1	3.25	1.0325	.016	4	8.80	1.088
17	—	.058	.007	8.3	3.60	1.036	.014	4.1	8.60	1.086
—	15	.057	.007	8.1	3.70	1.037	.014	4.1	8.60	1.086
—	16	.051	.007	7.3	4.20	1.042	.014	3.6	9.60	1.096
18	—	.049	.007	7	4.40	1.044	.014	3.5	9.80	1.098
—	17	.045	.005	9	3.25	1.0325	.012	3.75	9.30	1.093
19	—	.042	.005	8.4	3.55	1.0355	.012	3.5	9.80	1.098
—	18	.040	.005	8	3.75	1.0375	.012	3.33	10.10	1.101
—	19	.036	.005	7.2	4.30	1.043	.005*	7.2	5.60	1.056
20	—	.035	.005	7	4.40	1.044	.005*	7	6.00	1.06
21	20	.032	.005	6.4	5.00	1.05	.005*	6.4	6.60	1.066
22	21	.028	.005	5.6	6.00	1.06	.004*	7	6.00	1.06
23	22	.025	.005	5	7.00	1.07	.004*	6.25	7.00	1.07
24	23	.022	.005	4.4	8.00	1.08	.004*	5.5	8.00	1.08
25	24	.020	.005	4	8.80	1.088	.004*	5	8.80	1.088
26	25	.018	.005	3.6	9.60	1.096	.004*	4.5	9.60	1.096
27	26	.016	.005	3.2	10.40	1.104	.004*	4	10.40	1.104
28	27	.014	.005	2.8	11.25	1.1125	.004*	3.5	11.25	1.1125
29	28	.013	.005	2.6	11.65	1.1165	.004*	3.25	11.65	1.1165
30	—	.012	.005	2.4	12.05	1.1205	.004*	3	12.05	1.1205
—	29	.011	.005	2.2	12.45	1.1245	.004*	2.75	12.45	1.1245

*Double Silk: 1 mil of silk insulation taken equal in weight to 1.25 mil of cotton covering.

15.—*Armature Resistance.*

The electrical resistance of the armature winding can be determined by the total length of wire wound on the armature, and from the sectional area of the conductor. If R denotes the total resistance of the armature wire, all in one continuous length, and if the machine has P pairs of magnet poles, and, therefore, $2P$ electrically parallel armature portions, then the armature forms the combination of $2P$ parallel branches of $\frac{R}{2P}$ ohms resistance each (see Fig. 13). The joint resistance of these $2P$ circuits, that is the actual armature resistance, will consequently be

$$r_a = \frac{R}{(2P)^2} = \frac{R}{4 \times P^2}.$$

The total resistance, R, of all the armature wire in series can be calculated from the total length, L_t, and the sectional area, δ^2_a, of the conductor by the formula

$$R = L_t \times \frac{10.5}{\delta^2_a},$$

where 10.5 is the resistance, in ohms, at 15.5° C (= 60° Fahr.), of a copper wire of 1 circular mil sectional area and

1 foot length, and of a conductivity of about 98 per cent. of that of pure copper. The quotient $\frac{10.5}{\delta^2_a}$, for commercial copper, or $\frac{10.32}{\delta^2_a}$, for chemically pure copper, represents the resistance per foot of the armature conductor, and can,

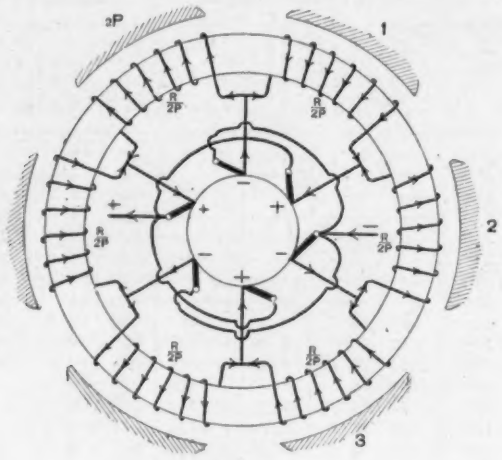


FIG 13.

for every standard size of wire, be taken from the wire gauge table.

Introducing the value of R into the above equation, we obtain the following formula for the resistance at 15.5° C., of any armature having a single conductor:

$$r_a = \frac{1}{4 \times P^2} \times L_t \times \left(\frac{10.5}{\delta^2_{a_1}}\right). \qquad (30)$$

r_a = resistance of armature winding at 15.5° C., in ohms;
P = number of pairs of magnet poles, eventually half the number of parallel armature portions;
L_t = total length of armature conductor, in feet, formulae (19) to (27), respectively;
$\delta^2_{a_1}$ = sectional area of armature conductor, in circular mils, formula (4).

In an armature, each conductor of which consists of p parallel strands of wire of $\delta^2_{a_1}$ circular mils sectional area, there are $2P$ parallel circuits of p wires each, or altogether $2 \times P \times p$ parallel circuits of $\frac{R}{2 \times P \times p}$ ohms resistance each; the joint resistance, therefore, is

$$r_a = \frac{R}{4 \times P^2 \times p^2},$$

and since in this case the total resistance of the whole armature wire in series is

$$R = L_t \times p \times \left(\frac{10.5}{\delta^2_{a_1}}\right),$$

we obtain for the resistance at 15.5° C. of any armature winding consisting of p strands of wire of $\delta^2_{a_1}$ circular mils sectional area, the formula

$$r_a = \frac{1}{4 \times P^2 \times p^2} \times L_t \times p \times \left(\frac{10.5}{\delta^2_{a_1}}\right) = \frac{1}{4 \times p \times P^2} \times L_t \times \left(\frac{10.5}{\delta^2_{a_1}}\right). \qquad (31)$$

In formulae (30) and (31) the number of pairs of poles, P, is to be replaced by half the number of parallel armature portions if these two numbers differ from each other.

In order to obtain the armature resistance at any other temperature, higher than 15.5° C., add 1 per cent. for every 3 degrees centigrade over 15.5°. The resistance, r_a, at 15.5° C., being known, the armature resistance at $t°$ centigrade consequently will be

$$(r_a)_{t°} = r_a + \frac{1}{100} \times r_a \left(\frac{t° - 15.5°}{3}\right) = r_a \times \left(1 + \frac{t° - 15.5°}{300}\right). \qquad (32)$$

16.—*Energy Losses in Armature.*

There are three sources of energy dissipation in the armature, which are transformed into heat: (1) Overcoming of electrical resistance of armature winding, (2) overcoming of magnetic resistance of iron, and (3) generation of electric currents in the armature core.

a.—Energy Dissipated in Armature Winding.

The energy required to pass an electric current through any resistance is given, in watts, by the product of the square of the current intensity, in amperes, into the resistance, in ohms. The energy absorbed by the armature winding, therefore, is:

$$w_a = C^2 \times r'_a, \qquad (33)$$

where w_a = energy dissipated in armature winding, in watts;
C = total current generated in armature, in amps.;
r'_a = resistance of armature winding, hot, in ohms; see formulae (30), (31) and (32).

The total current, C, in series wound dynamos, is identical with the current output c; in shunt and compound wound dynamos, however, C consists of the sum of the external current, c, and the current necessary to excite the shunt magnet winding. The amount of current passing through the shunt winding is the quotient of the potential difference, e, at the terminals of the machine, by the resistances of the shunt circuit, r_m, that is the sum of the resistance of the shunt winding and of the regulating rheostat, in series with the shunt winding.

For the resistance, r'_a, of the armature winding, when hot—in order to be on the safe side in determining the armature losses—that at about 75° C. should be taken, or, according to formula (32) the resistance, r_a, at 15.5° C., multiplied by $\left(1 + \frac{75° - 15.5°}{300}\right) = 1.2$.

The energy dissipated in overcoming the resistance of the armature winding, consequently, can be obtained from the formula:

$$w_a = 1.2 \times \left(c + \frac{e}{r_m}\right)^2 \times r_a. \qquad (34)$$

If w_a is to be computed before the field calculations are made, that is to say, before r_m is known, it is sufficiently accurate for practical purposes to express, from experience, the total armature current, C, as a multiple of the current output, c; and, therefore, we have approximately

$$w_a = 1.2 \times (k_6 \times c)^2 \times r_a \qquad (35)$$

and in this the coefficient k_6 can be taken from the following table:

TABLE XXII.—TOTAL ARMATURE CURRENT IN SHUNT AND COMPOUND WOUND DYNAMOS.

Capacity in Kilowatts.	Shunt Current in per cent. of Current Output.	Total Current, as Multiple of Current Output. k_6.
·1	15%	1·15
·25	12	1·12
·5	10	1·10
1	8	1·08
2.5	7	1·07
5	6	1·06
10	5	1·05
20	4	1·04
30	3·5	1·035
50	3	1·03
100	2·75	1·0275
200	2·5	1·025
300	2·25	1·0225
500	2	1·02
1000	1·75	1·0175
2000	1·5	1·015

(To be continued.)

Some Storage Battery Phenomena.*

BY W. W. GRISCOM.

The study of a complete curve of discharge of a storage battery discloses three rather sharply defined changes in P. D., and after allowing for the effect of internal resistance, it is found that the changes are those of the E. M. F., and possibly a resultant of three or more sets of chemical reactions. The conversion of $H_2 Pb_2 O_5$ into $H_2 Pb_2 O_7$ in the positive plate would account for the abnormal rise of E. M. F. at the end of charge, and if it be assumed that the latter compound is not stable but will yield ozone gradually, this would account for the steady fall of E. M. F. on interrupting the charging current. The chemist will easily see the relation between these reactions, and the presence of peroxide of hydrogen and the continual evolution of oxygen from the positive plate, and the fact that a charged cell gradually loses its charge, maintaining for days a higher temperature than the air. The differences in temperature between certain plates of a cell and even between different parts of the same plate, many of them very minute, are due to at least two causes, the liberation or combination of sulphuric acid on the one hand, and $C_2 R$ on the other.

It may be considered proven that in a storage battery with plates of nearly equal capacity, the changes in the positive plate determine the characteristic curves of potential on discharge, and that the changes in the negative plate determine the characteristic curves of potential at the end of the charge.

A curious feature in charge is the intersecting of the curves of the positive and negative plate at several different points. At the beginning of charge the two plates are at nearly the same potential; the positive potential then rises rapidly until it reaches 2.22 volts, when it begins to rise in a straight line strictly proportional to time. The negative, on the other hand, rises gradually until it reaches 2.18 volts, then it rises rapidly, intersecting the positive curve in 14 1-2 hours and at 2.24 volts, and continuing to rise until it reaches 2.40 volts in 16 3-4 hours; thereafter it remains constant for the five hours which the positive requires to reach the same potential. Within the working limits of charge and discharge, the negative does not vary 2 per cent. in P. D., and ultimately the positive shows more capacity than the negative.

In some experiments described, the curious phenomenon was presented of variations of current amounting to 30 per cent. in plates manufactured rigorously alike, kept in parallel and subjected to like treatment during their previous life. In cases where the discharge is pushed below 1.8 volts even more serious differences have been observed, amounting to a variation of 225 per cent., one reading being 2.8 amperes, another 6.4 amperes for perfectly good new plates carefully treated.

Perhaps a still more curious fact was the differences of E. M. F. of the plates in the same cell discharging through equal resistances and connected finally in parallel to the same circuit—the E. M. F. ranging from 1.60 volts to 1.85 volts for neighboring plates in parallel in the same cell, at the same time. On interrupting the circuit at the end of the discharge of a cell, a considerable flow of current, as might be expected, passed from one plate to another and it was hours before the batteries reached equilibrium after the external circuit was open.

The discharge of one positive into its neighbor was a rather unexpected result. It had been thought that if one plate had less capacity than its neighbor it would simply stop discharging at a certain point, but that its E. M. F would always be equal to that of its neighbors and that, therefore, no current would flow. The explanation of the phenomenon appears to be that the deficient plate keeps on discharging at a lower rate than the perfect plate, and finally reaches a much lower point of discharge. On interrupting the current the plate which has not been discharged so far rapidly recovers a higher voltage than its neighbor and, therefore, discharges into it. This effect must also take place in the different parts of any one plate, and may be a cause for the formation of peroxide on the surface of a negative plate after a discharge, a phenomenon which has been remarked by too many observers to be ignored.

The two outside negatives give more than their proportional amount of current on discharge, the current being actually less than on the other plates, the potential remains higher, and the discharge is therefore a little greater. This in turn affects the positives next to them and these positives are usually the first to disintegrate in a carefully used cell. This fact was most noticeable in batteries used on the Eckington and Soldiers' Home Railway at Washington, where out of 45,000 positive plates, there did not occur a single instance of buckling, and yet the outside positives always showed greater disintegration than the others.

The tendency of one part of a plate or one portion of peroxide to discharge faster or slower than its neighbor is one of the reasons which has led to the adoption of equipotential methods of connecting up the several plates of the storage battery. It is to be noted that these phenomena occur to a serious extent only when the batteries are discharged below 1.95 volts of potential difference per cell.

The experiments afford the most complete proof of the irregularity of the chemical actions which produce the electromotive force of the battery. Now one plate is given current, now another. And most remarkable of all, the different sides of the same plate exhibit differences of potential at their terminals which can only be attributed to differences of internal resistance, both in the electrolyte within the plates and in the porous active material itself.

The active material during charge and discharge is undergoing chemical change irregularly, not merely in the different plates, but in the different sides of the same plates, and as the active material is made up of large numbers of little pellets isolated from one another by the grid, the conclusion seems inevitable that one side of a given pellet is active to a different degree from the other side. It is not necessary to conceive that the E. M. F. generated on one side of a pellet is as different from the E. M. F. of the other side as would be indicated by the potential difference at the plate terminals. The more reasonable conception appears to be that the internal resistance of one side of a pellet is sometimes greater, sometimes less, than that of the other side, varying with the unequal chemical action. But I cannot escape the conclusion that there must be some real difference of potential and consequently local action—not merely between the parts of the grid, but between opposite sides of the same pellet or paste. This would account for the fact observed by Ayrton that a working cell is always above the temperature of the air—even when its own temperature is falling in discharge.

As to the latter phenomenon, as the addition of sulphuric acid to water raises the temperature, it is natural to infer that the removal of the acid from the water will lower the temperature. The former occurs on charge and the latter on discharge.

The potential of the cell is partly due to the degree of charge of the positive, partly to that of the negative and partly to the electrolyte. If a couple be removed to a stronger or weaker electrolyte the E. M. F. will rise or fall accordingly, so that the measurement of the P. D. of the terminals is not an invariable indication of its condition of charge, particularly if one plate is further discharged than the others. The variations of specific gravity of the electrolyte are practically determined by the ampere hours of using

* Abstract of a paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

charge, barring local action, short circuiting, change of temperature and a gradual sulphating of discharge positives when idle.

The variations of internal resistance of the cell afford a valuable indication of the condition of its active material, and therefore of its degree of charge. These variations have been attributed to various sources, but as yet our knowledge is not sufficient to afford a convincing explanation.

Experience shows that it adds greatly to the life of a cell and brings other advantages, to stop the charge between 2.1 and 2.45 volts and to stop the discharge at 1.9 or 1.95 volts. The positive plate is usually made of greater capacity than the negative, but the propriety of so doing is doubtful, as it may lead to over discharging the negative.

In a storage battery where the possible chemical reactions are complex the changes are governed by the P. D. as well as by the current; perhaps the current governs the amount of chemical action and the potential the kind. If a plate pasted with red oxide of lead is opposed to a plain lead grid in a forming bath the formation of peroxide proceeds evenly and uniformly in the well-known way, and the same is true if opposed to a pasted plate. But if it be opposed by another positive plate a different action ensues and the unformed plate cannot be properly converted to peroxide until the other positive has been completely reversed in a negative, this raising the P. D. of the cell.

It has been observed that when a single positive is suspended freely a great distance from the negative in the centre of a large jar the buckling is invariably away from sunlight. The plate may be turned around and moved quite close to one negative or the other, yet the buckling repeats itself invariably from the light. As a consequence, it would seem that storage batteries should be kept in the dark.

The rare phenomenon of automatic discharge of a positive plate was encountered in a case where a cell was reversed experimentally. The reversing charge was continued for 470 hours, or three times the normal capacity of the cell, and a potential of 2.41 volts obtained, charging rate being low. The current was then interrupted, the E. M. F. gradually fell to 2.92 volts in a perfectly normal way, but after 35 minutes the battery suddenly entered a state of violent, almost explosive, ebullition, giving off pure oxygen in immense quantities. Fifteen minutes later the cell was quiescent, the voltage had fallen to .84 and the specific gravity to the lowest point reached 470 hours before. Two or three days later the E. M. F. was zero.

Perhaps the most striking peculiarity about the modern storage battery is the diversity of opinion among professional electricians as to its utility and commercial value. Broadly stated, the European consensus of opinion, both technical and commercial, may be said to be in favor of storage batteries. The American view until now has been mainly the opposite. Storage batteries are almost always an economical success abroad, while here they have been too often an economical failure in the past. And the reason is that the Europeans always demand a margin for safety, while the Americans, with less capital and keener competition, are tempted to sail too close to the wind.

A storage battery continually worked to its commercial rating is a commercial failure. A storage battery worked sufficiently within its capacity is invariably a commercial success. A battery's discharge should be stopped after its E. M. F. has fallen to 2 volts or at farthest to 1.9, unless it be desirable to draw upon its reserve. It should be understood that a full discharge, that is, to 1.8 volts, is working a battery to the danger limit and is inadvisable, for the reason that the regulation is troublesome, the efficiency is low, dangerous molecular changes take place (as indicated by changes of internal resistance and changes of electromotive force, as well as occasional buckling), uneven plates discharge into one another after the circuit is interrupted, and the life of the battery is diminished. In watching with the closest scrutiny a considerable number of plants, aggregating perhaps some millions of plates, and classifying the failures and successes, it was found that when a battery was exhausted to its full capacity daily its life did not exceed 500 discharges, but wherever it was worked within two-thirds of its capacity complaints were unknown.

It is natural to ask why the rating should not be changed so that the owner of the battery would not be tempted to work it to the danger limit. That is a commercial question. In these days of close commercial figuring it would be difficult to sell a battery which appeared, caeteris paribus, to cost 50 per cent. more than its competitors. The present rating is strictly accurate and has the sanction of custom the world over. It is only necessary for the engineer to remember to add 50 per cent. of the capacity as a factor of safety to his maximum load, just as he allows several hundred per cent. in calculating the strength of a bridge, or an axle. This additional amount is not a dead loss in investment. It produces many countervailing advantages. It saves the necessity for regulation in most instances. It provides a very effective and safe reserve for cases where the charging apparatus breaks down and for many other cases, and it improves the actual efficiency of the battery, which rises from about 80 per cent. to nearly 90 per cent. when used with a sufficient reserve. And for cases where it is necessary to maintain a constant difference of potential, such as electric lighting, it raises the efficiency much more, because in these cases the commercial efficiency must be rated not from the average point of electromotive force but from the lowest point to which the battery falls on discharge, and when used in this way the P. D. drops only 2 1-2 per cent. All the E. M. F. above the lowest point must be wasted in order to secure regulation, unless the troublesome method of regulating by the introduction of extra cells is adopted. In circuits where this regulation is of no consequence as, e. g., motor circuits for cars, all the E. M. F. is utilized in increasing the car miles per unit of energy.

A storage battery for trolley systems or other central stations for the production and utilization of electricity has heretofore been regarded in this country as a very expensive addition to the plant, but this is not always the case. There are many opportunities for introducing storage batteries as a part of the original plant without increasing the cost, as, for example, in cases where the maximum output is two or three times greater than the average output. In a calculation with Emery's figures for a basis for the steam plant, it is shown that a 1,000-h. p. direct system would cost $92,500, and a 1,000-h. p. storage system $91,250.

The following conclusions are stated:

1. That the chemical reactions in a storage battery cell must be complex, in order to account for the curves of E. M. F., temperature and internal resistance.

2. That the current and the E. M. F. of the component plates of a cell, and of each part of each plate, are constantly fluctuating, in spite of the fact that no source of electricity can compare with a storage battery for steadiness and constancy.

3. That by reducing the normal output of a battery by about 30 or 40 per cent. the discharge can be mainly confined to one set of chemical reactions, thus prolonging the life of the battery.

4. That the negative and positive plates are apt to get out of step, therefore the battery should be given an occasional overcharge when necessary, but only when necessary, to get them in line again.

Steam Engines for Electric Lighting in Germany.

At the beginning of the year 1893 1,407 engines of a total of 76,045 h. p. were used in the kingdom of Prussia for the production of electricity.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE

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ELEC. WORLD, N.Y.

ELECTRO-PHYSICS.

Afterglow of Geissler Tubes.—A paper by Mr. Kirn is reprinted in the Lond. "Elec.," June 1, from the "Wied. Ann.," No. 6, page 381. It gives the results and spectroscopic observations made of the afterglow and shows that the phenomenon of the extinction of this glow is the exact reverse of that which takes place when bodies begin to glow. Regarding the cause of the afterglow, he states that he believes that it is the result of a chemical modification of the contents of the tube.

Leyden Jar Discharges.—A communication by S. Alfred Varley on "A Call for More Imagination as a Factor in the Progress of Physical Science, and a Few Remarks on Maxwell's Electrical Theory," is published in the Lond. "Elec. Rev.," June 1. He claims that Mr. Wimshurst has demonstrated conclusively that Leyden jar discharges pass through the mass of a conductor, and are not confined to the outer layer; he claims to be able to demonstrate that Leyden jar discharges are not oscillatory if some one else will pay the expenses of the demonstration, but he does not describe how he proposes to demonstrate it.

Effect of Light on Electric Discharges.—A paper by Prof. Koenig on this subject is abstracted briefly in the "Elek. Zeit.," May 24.

Atmospheric Electrification.—In a note in the Lond. "Elec.," June 1, it is stated that according to the observations of Mr. Lachner, the St. Elmo's fire has shown the fact that when snow falls in large flakes the electricity is almost always positive and when it consists of dust-like particles negative electricity is developed.

Resistance of Selenium.—In a communication to the Lond. "Elec. Rev.," June 1, Mr. Mayhew claims that he was the first to discover, in 1872, that the resistance of selenium changes when exposed to light.

Vortex Theory of Electrodynamics.—"La Lum. Elec.," June 2, contains the first part of a mathematical article by Mr. Blondin on this subject.

Reflection of Waves.—A paper by Messrs. Sarasin & Birkeland from "Comptes Rendus" is reprinted in "La Lum. Elec.," May 26.

MAGNETISM.

Earth's Magnetism.—A description of an instrument used in the Russian Observatory for the absolute determination of magnetic declination is given in the "Elek. Zeit.," May 24. In another note in the same issue it is shown that the sun and moon and possibly the planets also have an influence on the earth's magnetism; Mr. Wild discusses the subject and concludes from some quantitative calculations that these effects would be small, those from the planets being probably inappreciable.

Magnetic Properties at Different Temperatures.—Mr. Curie's paper, mentioned in the Digest June 9, is very briefly abstracted in the Lond. "Elec.," June 1.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing of Transformers.—The "Elek. Zeit.," May 24, abstracts from the official report of the Frankfort Exhibition the results of the tests with Mordey, Schuckert and Oerlikon transformers. At full load the loss in the heating coils was 2.3 and 2.5 per cent. in the Mordey, 2.36 in the Schuckert and 1.75 per cent. in the Oerlikon transformer; in the two former the loss in the iron was independent of the load, but in the Oerlikon the loss rose with an increase in load, like the loss in the copper; the efficiency of the small Mordey transformer was 94.5 per cent. and of the large one 96.3, of the Oerlikon and Schuckert 94 per cent., all at full load.

It discusses, though not very clearly, the accuracy and the precautions of the method of testing transformers by means of a wattmeter. A short abstract of this is given in the Lond. "Elec. Eng.," June 1.

Testing Alternate Current Motors.—See abstract under "Transmission of Power."

Municipal Testing of Meters.—According to the "Elek. Zeit.," May 24, the Austrian Government has decided that all electric meters used by consumers must be calibrated and officially stamped by the government; a brief description of the conditions is given.

Measuring Phase Difference.—In an article by Mr. Engelmeyer in "La Lum. Elec.," May 26, he describes the experiments of Von Ettingshausen and Puluj and the new combination of the Lissajous mirrors, mentioned in the Digest May 19.

Calculating Polyphase Currents.—A paper by Mr. Blondel from "Comptes Rendus" is briefly summarized in the Lond. "Elec. Eng.," June 1, in which the formulas are given for a "new simplified method for calculating polyphase alternating currents."

Power of Three-phase Circuits.—Some formulas from an article by Dr. Froelich are given in the Lond. "Elec. Eng.," May 25.

Combined Ammeter and Voltmeter.—An instrument is described in the Lond. "Elec. Eng.," June 1, which has two pointers and two scales, one reading amperes and the other volts.

ARC AND INCANDESCENT LIGHTS.

Lamp Tests.—According to the Lond. "Elec.," June 1, an exhaustive examination of a large number of lamps is now being made by Mr. Preece, the report of the tests being intended for a communication to the British Association; the lamps will be run for more than 3,000 hours.

Incandescent Lamps of Variable Candle Power.—A new lamp mentioned in the Lond. "Elec. Rev.," June 1, contains

two filaments, presumably of different candle powers each, connected with a switch, by means of which they may be connected singly, in series, or in parallel, giving four different degrees of illumination.

Incandescent Lamp.—In the continuation of Mr. Bainville's serial in "L'Elec.," May 26, he discusses the bulb, the support of the filament, the mounting and the securing of the filament. A translation of this article is being given in the Lond. "Elec. Rev."

Best Efficiency of Incandescent Lamps.—See abstract under "Advantages at Constant Voltage."

Cored Carbon Litigation.—A decision in favor of Siemens is announced in the "Elek. Zeit.," May 31; also more fully in the "Elek. Echo," May 26.

TRANSMISSION OF POWER.

Transmission of Power.—The conclusion of Mr. Boucherot's article, mentioned in the Digest June 9, is published in "La Lum. Elec.," May 26. A description is given of the agricultural machines driven by the two-phase motors on the Menier farm, in which two two-phase motors of 15 and 20 h. p. and one single-phase motor of 1 1-2 h. p. are used; the advantages of using such motors instead of continuous current motors are pointed out. Curves are given for both the double and the single phase motor, showing the current, the speed, the efficiency and angle of lag for different outputs, the efficiency being very high, especially in the two-phase motor; he describes a method for testing, in which the efficiency is calculated from the loss, all of which are determined separately; the loss due to the resistance in the short circuited armature is determined by the power at the pulley and the loss in the velocity; the results of the direct determinations and those obtained by this method are given in parallel columns, showing that for two-phase motors the latter method can be used, but for single phase the efficiency is from 2 to 3 per cent. too high. The efficiency of the whole transmission is 61.3 per cent. for a mean load on all the three motors. The arrangement for starting the motors is described, but not very clearly; it appears to consist of a combination of a transformer for increasing the current, with self-induction coils, of which different portions can be put into circuit.

ELECTRIC RAILWAYS.

Electric Traction.—An editorial article in the Lond. "Elec. Rev.," June 1, discusses the recent statements of Prof. Kennedy regarding electric traction, quoted from several sources and maintaining that his estimate of an efficiency of 35 per cent. is nearer correct than any made by his critics.

Mountain Railway.—A very good description, together with some illustrations, of the recently installed rack and pinion electric railway on Mont Saleve, near Geneva, is given in the "Elek. Zeit.," May 24.

Budapest Railway.—A short description and a few figures, although containing nothing new, are given in the Lond. "Elec. Eng.," June 1.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Station Statistics.—A very good and interesting set of statistics of 21 central stations in Germany for one year, from 1892 to 1893, is given by Dr. Gusinde in the "Elek. Zeit.," May 24. They were collected for the Union of the Representatives of Central Stations. The tables do not admit of being abstracted; they contain information of considerable interest to central station managers; out of the 21 stations all but two use accumulators. Among some of the general deductions are the following: The weight of the copper in kilograms in the whole distribution per hekto-watt hour of the total output of the station is given for each of the stations and averages between seven and nine, one of the lowest figures, 3.07, being for the alternating current station in Cologne; the lowest is 1.78, for the small station in the city of Muelhause. Another column gives the average load on the generators in percentage of the normal, and as most of the stations use accumulators, the figures are quite high, four of them being 100 per cent. and ranging in others to 80 per cent. and some lower; for the only alternating current station the figure is not given. The efficiency of the accumulators for the year is above 90 per cent. in ampere hours for most of the stations, reaching as high as 98 in one of them, while in watt hours the average is somewhat less than 80 per cent., the highest being 82 per cent. Another column gives the ampere hours from the accumulators in per cent. of the total output of the station, a figure which varies considerably, the highest being 74.7 and the lowest 15. The average price per kilowatt hour appears to be a little over 18 cents, from which a reduction is made for larger quantities; for other purposes than light the average cost appears to be almost half and in some cases even less. A few of these figures are abstracted in the Lond. "Elec. Eng.," June 1.

Advantages at Constant Voltage.—In an article by Mr. Claude, the first part of which is published in "La Lum. Elec.," June 2, he points out the great advantage of keeping the voltage at the consumer's end of the circuit absolutely regular and shows that in the three-wire system this is not possible; he claims that in the future this fact will be of very great importance and that it is an inherent defect in the three-wire system. From the life of a 16-c. p. lamp, run at different efficiencies, he constructs a curve, the abscissae of which are the cost per lamp hour and the ordinates the watts per candle, the price of the lamp being taken as 40 cents and the cost of the energy 2c cents per kilowatt hour; this curve has a minimum at about two watts per candle, which is therefore the best efficiency at which the lamps should be used; if the lamps cost only 20 cents, he finds a second curve having a minimum point at 1.7 watts per candle; at present, however, the lamps are used (in France), as a rule, at 3.5 to 4 watts per candle, at which point the curves are almost superposed, showing that at that efficiency the price of the lamp makes but very little difference in the total cost, but for a lower consumption per candle there is a gain both in the cost of the lamp and in the cost of the energy; to use lamps at as good an efficiency as 2.5 watts per candle is, however, almost impossible on the present circuits (in France), even at the price of 20 cents per lamp, on account of the variations in the voltage. What should be striven for, therefore, is absolute regularity in the difference of potential and an efficiency of 2.5 watts per candle with a tendency toward two watts per candle.

Electric Power in Workshops.—A paper by Mr. Selby Bigge is abstracted briefly in the Lond. "Elec. Eng.," June 1. It is stated that in a number of different workshops he found that when a motor was running a shop with a large number of small lathes and other like instruments, more power was absorbed when the tools were not in use than when they were doing normal work. He believes that rolling mills can, and will, be operated electrically. He cites a number of cases showing the advantages in using electric motors; in one factory the saving was 30 tons of coal per week; in a factory in Liege the saving was as three to seven; in another five or six engines and four boilers were replaced by one engine, one boiler and one dynamo, and the resulting saving was two tons of coal out of three per day; the same ratio was reported in other cases; the efficiency in the Liege factory was 71.3 per cent.

Cost of Electrical Energy.—A continuation of the discussion of Mr. Crompton's paper is published in the Lond. "Elec. Rev.," June 1, and is limited almost entirely to the mechanical engineering features. The same issue contains a long editorial on fuel economy, and likewise the second part of an article by Mr. Booth, also devoted to the mechanical engineering features. The discussion is

given somewhat more fully in the Lond. "Elec.," June 1, in which issue the paper is also discussed editorially. The Lond. "Elec. Eng.," June 1, publishes Mr. Crompton's reply to the discussion.

Three-Wire Distribution with a Single Dynamo.—A translation of the article, with illustrations, mentioned in the Digest May 12, is published in the Lond. "Elec. Rev.," June 1; the system was described and illustrated in the Digest Feb. 3.

Engine Power at Central Stations in Prussia.—The "Elek. Zeit.," May 24, publishes, from the official statistics, the number of steam engines and their total power used for generating electricity, and their sub-division into different classes of work; the total at the beginning of last year was 1,407 steam engines with a total of 76,045 h. p.

Dust Destructors.—A report of different systems proposed for the Chelsea Vestry is reprinted in the Lond. "Elec. Rev." and "Elec. Eng.," June 1.

Steam Turbine.—A description and cross-section of the Parsons steam turbine are given in "La Lum. Elec.," May 26.

Brighton.—A description of the Brighton station, including a number of illustrations, among them the complete connections of the switchboard, is published in the Lond. "Elec.," June 1; the three-wire system, with low tension continuous currents and accumulators, is used.

Christiania.—Some tabulated figures regarding the operation of this station are given in the "Elek. Zeit.," May 31.

Insurance Rules.—The "Elek. Zeit.," May 31, publishes at considerable length a discussion by Dr. Gusinde of the proposed modifications of the insurance rules in Germany.

Lightning in High Tension Circuits.—A peculiar case is described in the Lond. "Elec. Rev." and "Elec. Eng.," June 1, by Mr. Preller, in which some high tension circuits in Switzerland were struck by lightning.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Storm Indicator.—A device is described by Mr. Engelmann in the "Elek. Zeit.," May 31, for notifying the central station and subscribers of the approach of a storm, so that the telephones can be cut out of circuit. The system seems to be worked out quite completely and involves a somewhat complicated system of connections, a diagram of which is given. At the most distant points of a system of telephone wires and on elevated points are placed electroscopes with a fixed and a movable aluminium plate, which latter is deflected by atmospheric electrification; when the deflection is of a sufficient amount a local circuit is closed through a relay, which starts an alarm signal at the nearest station, where it is transmitted to the subscribers; after a quarter to one-half a minute the apparatus is set again and if the electrification is still present the alarm bell will continue to ring.

Long Distance Telephony.—In an article by Mr. Anizan in "La Lum. Elec.," June 2, he shows that improvements in long distance telephony are no longer to be sought for in the line but in the instruments; he describes a combination of his bi-telephone (double telephone) with the arrangement described in the Digest May 19, involving two switches, one of which adjusts for long or short distances and the other, which affects the bi-telephone, to be moved when one is talking or listening, as it cuts out portions of the resistance of the receiving telephone.

Vienna and Berlin are to be connected by telephone this year.

Loudness of Some Microphones.—The "Elek. Zeit.," May 24, publishes the results for ten different microphones, giving their relative values as represented by the product of the resistance and the capacity at which audibility ceases; they are all of European manufacture; attention is called to the fact that the figure is higher for instruments with a horizontal diaphragm than with a vertical one.

Telegraph Poles.—A summary is given in the "Elek. Echo," June 2, by Mr. Arens, of some of the principal formulae for calculating the mechanical strength of poles for overhead lines.

Electric Signals for Men-of-War.—The Lond. "Eng.," March 30, contains an article on this subject.

ELECTRO-CHEMISTRY.

Primary Battery.—A Royal Society paper by Mr. Swan, abstracted in the Lond. "Elec.," June 1, describes experiments with a cell made with fused lead as positive electrode, carbon as negative and fused $PbCl_2$ as electrolyte, the depolarizer being chlorine in the form of a gas; it was found very necessary to expose the carbon to the action of the gas and electrolyte alternately in rapid succession; the lead dissolves as chloride of lead and is deposited on the carbon, where it is immediately reconverted to the chloride by the chlorine gas; the E. M. F. was 1.40, the theoretical being 1.7942 volts. The cell has a very low internal resistance and admits of great current density; a current of one ampere was given with 10 to 12 square centimetres of carbon plate; the internal resistance and depolarization decrease when the output increases, thus giving an almost constant voltage.

Erving Accumulator.—According to an illustration and brief description in "La Lum. Elec.," June 2, the cathode consists of copper on the outside of porous cups and connected with sheets of zinc; the anodes are formed of lead with 2 per cent. of silver, surrounded by a paste of peroxide of lead and sulphate of aluminium in the porous cups; the electrolyte is a solution of ammonia and acid bisulphate of mercury; during the charge the anode is oxidized and the amalgam is deposited on the cathode; during the discharge the cathode is oxidized and the hydrogen is deposited on the anode; no data are given about the output.

Tanks for Electrolysis.—For the electrolysis of solutions which contain acids it is stated in "La Lum. Elec.," May 26, that a protecting cement may be made of a mixture of pure, finely powdered asbestos with a thin solution of silicate of soda, as little alkaline as possible; the inside of the tank is painted with this cement.

The Electrolysis of Fused Electrolytes.—According to information from England, received by the compiler, the most important features in the Vautin process of the production of chlorine and soda from fused salt, described in the Digest June 2, were originally invented by an American.

Chromium.—According to "La Lum. Elec.," May 26, chromium may be obtained by electrolysis, deposited on a carbon filament such as that of an incandescent lamp, in a bath of 10 to 15 grams bisulphate of potash, 100 grams of chrome alum and 100 grams of water; the bath is replenished with chrome alum.

Simultaneous Production of Soda and Lead.—The Lyte process is briefly described in "La Lum. Elec.," May 26; it is a combination of the Solvay process for the production of soda, with a process of a treatment of litharge and argentiferous lead, thus producing simultaneously soda, chlorine, lead and silver.

Electro-Chemistry.—"La Lum. Elec.," May 26, describes the production of several mineral colors by electrolysis.

MISCELLANEOUS.

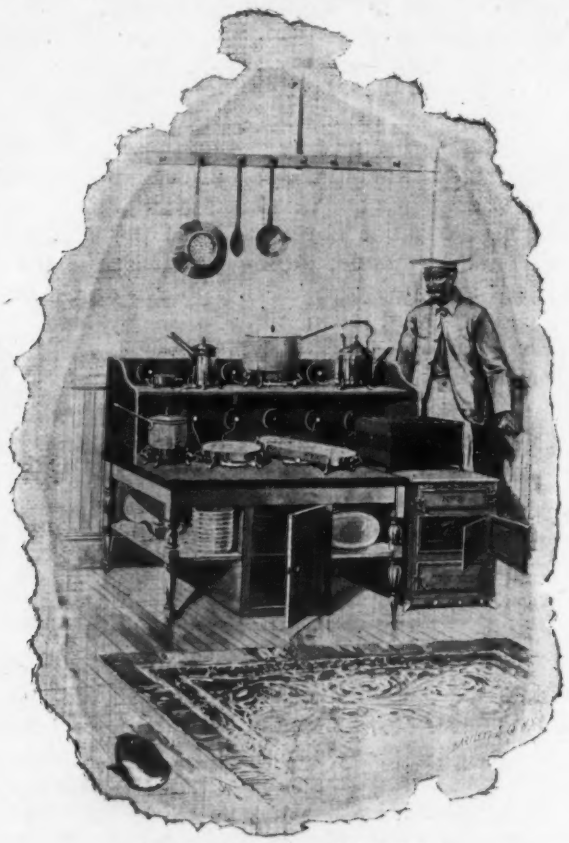
Diphtheria.—According to an article from "Cosmos," abstracted in "La Lum. Elec.," May 26, Mr. Erede has found that the bacteria of diphtheria perish in the light, and he suggests treating the disease by applying the light from an incandescent lamp, or from reflecting prisms, to the diseased parts of the throat.

Electric Launches.—A brief description of a few recently constructed launches used in Berlin is given in the "Elek. Zeit.," May 24.

Biographical.—A biography of Dr. Zetzsche is given in the "Elek. Zeit.," May 31. The death of the noted physicist, Dr. August Kundt, is announced in the "Elek. Zeit.," May 31. A short biographical notice is also given in the same issue.

Electric Cooking.

For several months the Central Electric Heating Company has been operating in a room adjoining its offices in the Havemeyer Building, New York, an electric kitchen, where daily an excellent lunch is cooked by electricity and served to those fortunate enough to obtain an invitation to witness and materially appreciate the results of this latest demonstration of the marvellous applicability of electricity to the needs of man. As the result of a gustatory experience we can testify to the excellent manner in which the food is cooked, to the absolute cleanliness of which the processes admit and to the entire absence of distressing heat. From the construction of the apparatus and visual evidence as to the certainty with which they admit of an exact result being obtained, we can also testify to the reasonableness of the claim that with electrical cooking apparatus not only may an ordinary servant rival a skilled chef, but the latter may, through its use, produce results far beyond present possibilities in

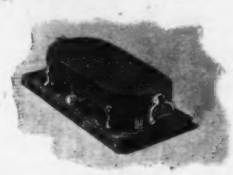


AN ELECTRIC KITCHEN.

cooking, not only on account of the absolute control of temperature, but also from the ideal manner in which the heat may be applied.

As to the economical side of the case, the cost of electrical energy as fuel under average conditions at the average power rates charged at present may be greater than fuel directly burned, but there are compensating advantages gained which more than offset the additional cost, if any. Of these are the saving of attendance and of time, freedom from dirt, coolness of the kitchen and the absolute uniformity of heat and ability to regulate it. There is no discomfort, no noxious gases from combustion, and the temperatures attained are constant, so that the question of the discretion of the cook is eliminated and better results obtained than can possibly be reached from the approximate temperatures of surfaces heated by combustion. The heat generated for cooking is almost entirely utilized in actually accomplishing the work of cooking, unlike the case of the ordinary range. There is no bringing in of coal or carrying out of ashes or raking of fires, it being much easier, it is needless to say, to turn a switch and have the heat energy introduced on a small wire than to handle coal and ashes. Moreover—and this is an important point in relation to relative cost—there is no heat wasted, except a very small amount by radiation.

We give a view of an electric kitchen of sufficient capacity to prepare the meals of from 15 to 25 people daily,



PORTABLE STOVE.

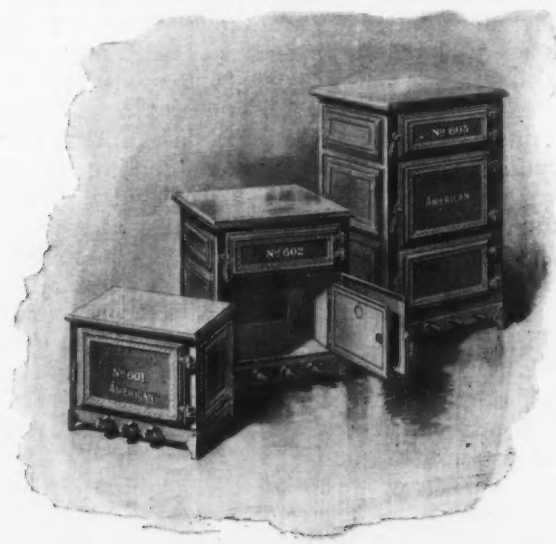
SAD-IRON.

CHAFING DISH.

but which, however, is arranged more after the lines of an ordinary kitchen than necessary. Owing to the cleanliness of the apparatus and processes, and the minimum of heat, there is no reason why the apparatus might not be so installed as to render the kitchen in exact keeping with the other apartments of even the most artistically furnished house.

The various apparatus illustrated require little explanation. The heat is produced by resistance wires or ribbons disposed between double sides or bottoms. The electric current, either direct or alternating, is turned on or off by a switch, and it is scarcely necessary to remark that there is no danger in handling the various devices, as they are constructed for use only with the safe currents used for house lighting. The utensils can be moved and attached anywhere there is an electric outlet by a simple plug; a lamp, for example, may be taken out of a bracket or chandelier, and the plug substituted, provided, of course, the current capacity of the apparatus is not greater that that of the lights or wiring.

Three sizes of ovens are shown. The smallest size, with one compartment 13 inches wide, 18 inches deep, and 9 inches high, is arranged for two different degrees of heat. The next larger has the same sized compartment, but with an additional one of the same width and depth and 4 inches high, for keeping articles warm or for slow baking. The largest size has an additional cooking chamber 7 inches high, with one heat. Meats roasted in these ovens have all the qualities that meats roasted in front of a fire have and do



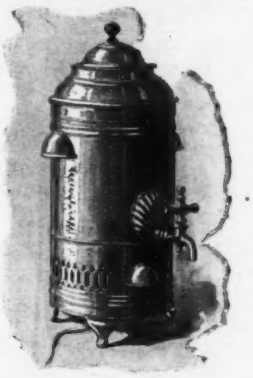
ELECTRIC OVENS.

not require basting or watching. They are cooked more evenly and in less time, while retaining a larger percentage of the nutritious juices. After the exact time required for cooking any material has been ascertained, it can be put in the oven and left there for the proper time without further attention, and, as a bread-baker, it is far more efficient than

present methods. These ovens give a steadier and more effective heat and do their work more perfectly in every way than the ordinary range oven. The degree of heat can be readily adjusted to the work and the "quick" or "slow" oven obtained with certainty whenever required.

The portable stoves, which also answer for griddles, are made in various sizes and shapes to adapt them to the usual sizes of the ordinary kitchen utensils to be found in every household. An assortment of them will entirely take the place of the range or stove. They are conveniently portable and furnish a uniformly heated surface more effective than the top of a hot range or stove heated by the alcohol lamp or gas flame. They are equally well adapted for use in the

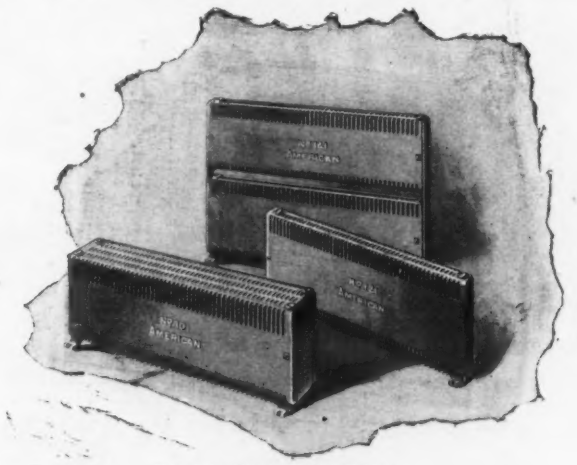
GRILL.



WATER URN.

nursery, living rooms or hospital wards and the kitchen, and are especially applicable to the ordinary forms of steam cookers, giving a steady, uniform temperature in the cooker and obviating all risk of either too violent boiling or of subsiding and cooling, to the detriment of the food being cooked.

The electric grills and broilers are ready in a few minutes after the current is applied, and the work is done without the food being singed, smoked, gas flavored or burned; the escaping juices are collected unspoiled in a pan beneath, so that the cook can baste the meat with its own juices, and thus all the elements of the food are saved. The broilers are so constructed that the working surface may be used wholly



ELECTRIC HEATER.

or in part, and are provided with a grease pan and a switch which can be operated to throw the heat on or off two or more of the sections.

In addition to cooking apparatus we illustrate some electric heaters, a sad iron and a glue pot; many other forms of apparatus are made, such as immersion heaters for melting pitch, curling tongs heater, etc.

There are days in the spring and fall when the usual services for heat are undesirable or unnecessary and recourse must be had to the ill-smelling gas or oil stoves or other auxiliary means of meeting the requirements. Often in hotels, apartment or dwelling houses, or in hospitals and on steamships and yachts, certain rooms are in need of special warmth, while the remaining rooms do not require it. In such a contingency the electric heater meets the requirements most satisfactorily. In warm climates, where the demand for heating is casual or spasmodic, the special advantages it presents are apparent.

GLUE POT.

TEA-POT AND STAND.

The heaters, as will be seen from the cut, are compact in form and are finished in japan, bronze or white enamel to match surroundings. They are made in such a variety of shapes that they can be fitted into convenient places in rooms, and are so readily connected and disconnected that when the season for their use has passed they can be removed and stored until required again. They are all 26 inches long and vary in height from 10 inches to 22 inches and in width from 2 inches to 10 inches, according to the amount of heat required and the place where they are to be used.

New Book.

ECONOMY IN MATHEMATICS. New Calculation Tables for Multiplication and Division. Also a Table of Roots and Powers. By Levi W. Meech, A. M. Norwich, Conn.: The Henry Bill Publishing Company. 1894. 910 pages. Price, $10.

This volume is primarily a multiplication table up to 999 times 999, and while there is nothing new in such a multiplication table, the present one is carried to a much greater length than usual.

The first multiplication table of which we have any knowledge was constructed by Pythagoras, and in the then state of arithmetical science in Greece, it must have been of the highest value in every-day affairs, as it is difficult for us in these modern times to conceive of any commerce being carried on, unless it be the rudest form of barter among savages, without some rudimentary form of arithmetical reckoning.

With the introduction into Europe by the Arabs of the Indian arithmetic (our present arithmetic), the necessity of the multiplication table, except the little corner which extends up to nine times nine, disappeared. Although up to nine times nine is all that it is strictly necessary to remember of the multiplication table, yet it is exceedingly convenient to be able to remember it much farther. It is very common, if not the usual practice, to teach up to twelve times twelve, and memorizing up to twenty times twenty or twenty-four times twenty-four is by no means rare.

It would accordingly seem that there is a very general opinion, although it may not be expressed in words, that it is well to memorize as much of the multiplication table as practicable without devoting an inordinate amount of time and study thereto. Moreover, the more expert one becomes in the use of figures, and consequently the better able to dispense with memorizing, the more able is he, as a rule, to retain the results of previous calculations in his memory.

Considered, therefore, as a Pythagorean table, pure and simple, the volume before us would be useful, and to any one having a large amount of multiplying to do, it would save much labor. It is, however, much more than a Pythagorean table, for by the use of certain auxiliary figures printed on each page, used according to a method described in the book, multiplication and division with any number of places of figures may be performed.

The labor involved in these operations to one who has mastered the methods is undoubtedly much less than by the ordinary arithmetical operations, but it will require some

study to become proficient in these operations, and it is unfortunate that the explanations are couched in language not at all clear or logical.

The auxiliary table of squares, cubes, square roots, cube roots and reciprocals, extends to 300. The roots are extended to seven places of decimals and the reciprocals to nine. There are projecting marginal indices at frequent intervals, so that the book may be opened almost instantly at any desired page. The binding is handsome and substantial, but the typography is not as good as could be wished, for, in a table of figures, above all other places, a clear and faultless imprint is important. The making of this book has involved an immense amount of patient labor, and considerable mathematical invention, and it belongs to a type recommended by no less an authority than the late Prof. De Morgan.

Direct Connected Engine and Dynamos.

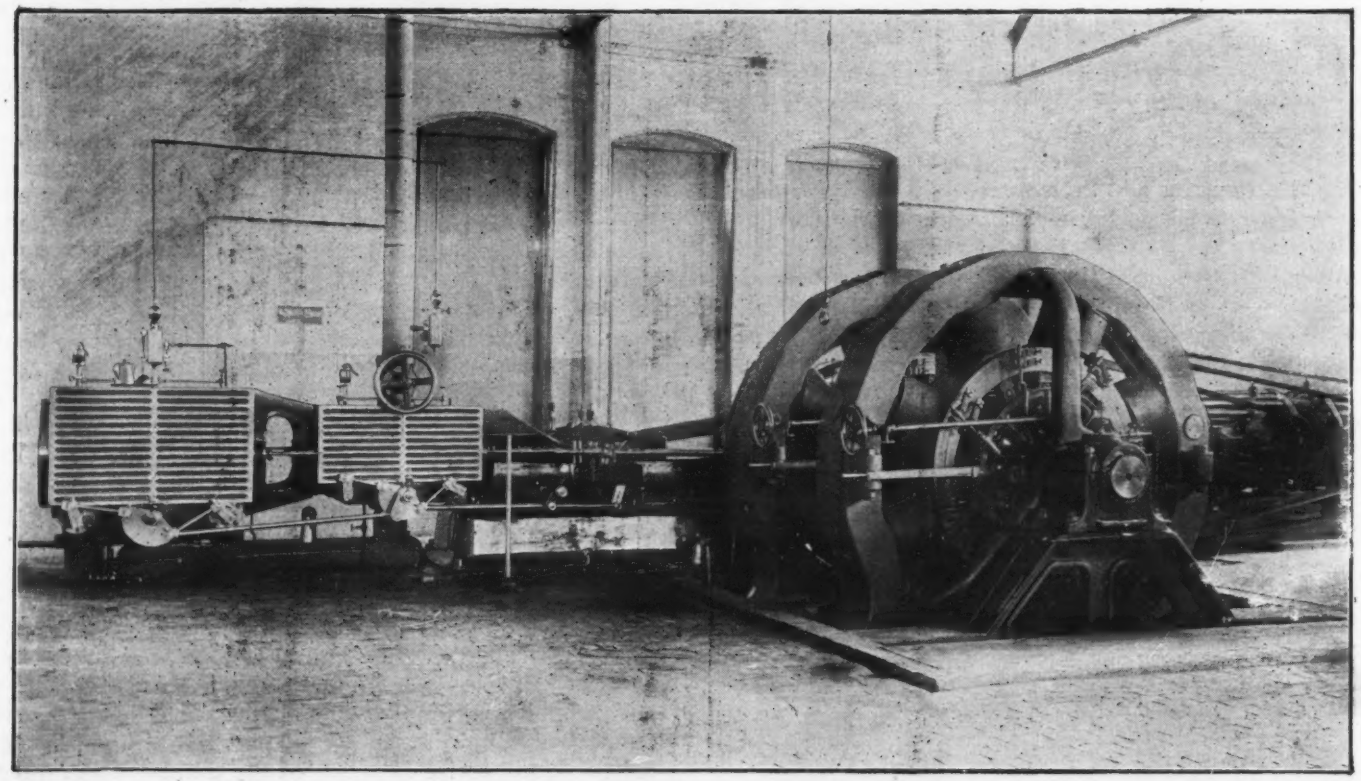
The direct coupled dynamos and engine which we illustrate were recently installed in the station of the Edison Electric Light Company, at Grand Rapids, Mich., and consist of one four-valve compound condensing engine, 15 by 24 by 24, rated at 300 to 400 h. p., built by Russell & Co., of Massillon, O., and two 100-kw. generators made by the General Electric Company. The bed of the engine and the fields of the dynamos rest upon a common iron base. The main shaft of the engine carries, in addition to the flywheel, the two armatures, and is supported in two pillow blocks mounted on detachable iron stands, so that the armatures may be moved without lifting the shaft out of place. The makers of the engines inform us that a test conducted by Mr. Frank A. Simonds, M. E., to determine the engine's economy in verification of guarantees, yielded the following results:

RUNNING NON-CONDENSING.		RUNNING CONDENSING.	
Duration trial, 6 hours.		Duration trial, 6 hours.	
Average steam pressure	139.5	Average steam pressure	130.
" revs. per min	162.	" vacuum	25.75
" I.H.P. developed	307.74	" revolutions	162.
Water per I. H. P.	18.45	" I. H. P.	327.75
		Water per I. H. P.	15.59

New Wood Arc Light Apparatus.

It is but a few years ago that a 50-light arc dynamo was considered a practical limit, and the occasional machine designed for a larger number of lights was viewed with such suspicion that but little headway could be made with them. The extent of this prejudice was illustrated in the report against 100-arc machines by the advisory committee in the matter of the Detroit municipal plant, and Mr. Dow, the city electrical engineer, is to be commended for the firm stand he then took in favor of machines of larger power, and also congratulated that his views have been so soon corroborated by the general change in opinion on the subject. The strong tendency toward larger machines was made particularly apparent at the discussion on the subject at the Washington Convention of the National Electric Light Association, which dispelled the last doubts in the minds of station men as to the practicability of 100-light machines, and demonstrated that no inherent difficulties need be expected in even much larger capacities.

It is but natural that one of the leaders in this movement should be Mr. Wood, of the Fort Wayne company, who in the past has rendered such signal service to arc lighting, and we illustrate in Fig. 1 a new machine of his design, with a capacity of no less than 150 2,000-c. p. arcs, which is now being placed on the market by the Fort Wayne Electric Corporation. The new machine is there contrasted, using the same scale, with the largest Fort Wayne machine previously built—an 80-arc machine (Fig. 2)—thus assisting to a clearer idea of the great advance implied.

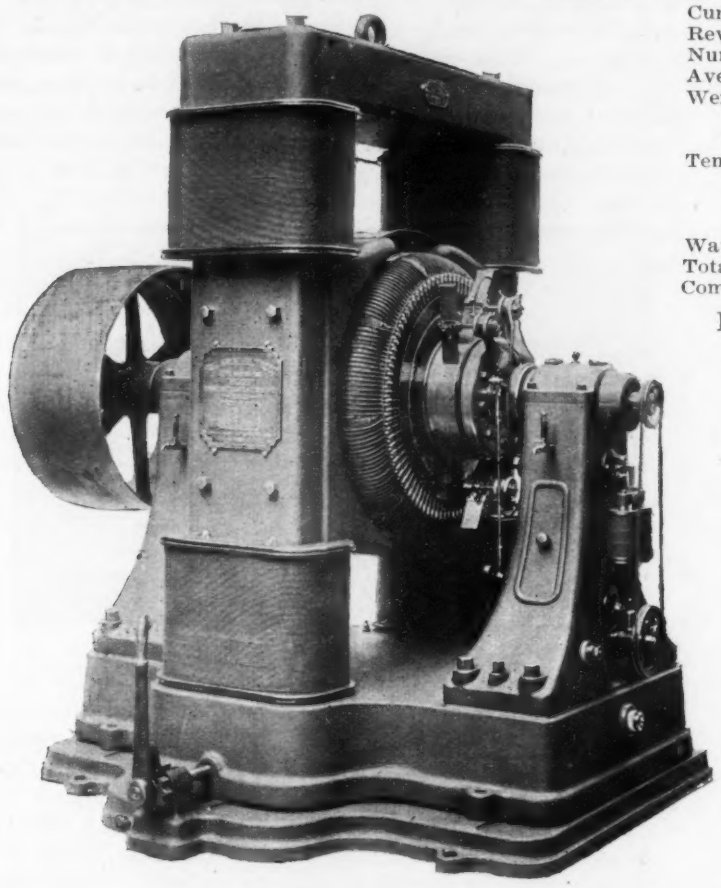


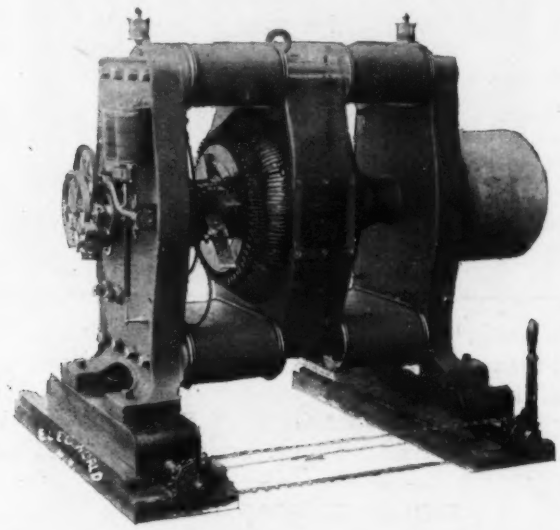
DIRECT CONNECTED ENGINE AND DYNAMOS.

It will be noted that in the new machine the field magnet frame has been placed in an upright position. The cores upon which the field coils are wound are massive wrought iron forgings, joined by a heavy cast iron yoke at the top and provided with cast iron pole pieces. The entire regulating mechanism is placed within the pillow block and is operated by a small round belt from a pulley at the end of the armature shaft. The regulation of the machine is effected after the manner of the Wood system, now well known and long tried. Sparking is almost entirely avoided by varying the

distance or the number of commutator segments, between the two positive and the two negative brushes. The regulation is such that the full number of lamps can be switched on or off without fear of endangering the machine.

The circuits of the machine and its connections are shown in Fig. 3. From these it will be seen that the machine is entirely self-contained. The wires leading to the circuits are taken from the binding posts at the base of the machine and carried below the floor to the switchboard, and thence through the lightning arresters to the outside circuits. This leaves the dynamo room entirely free from wires, which usually connect with the machine from overhead, thus giving the whole a substantial and neat appearance.





FIGS. 1 AND 2.—NEW AND OLD TYPE WOOD DYNAMOS.

On a recent test a machine of the new type operated 153 full arc lamps on the 38-mile circuit of the local Fort Wayne electric light company, for a period of 18 hours, after having been previously operated for 30 hours, making in all a continuous run of 48 hours. The following data regarding the machine will prove of interest and particularly the remarkable showing as to efficiency:

E. M. F. at terminals	7,050
Current in amperes	9.6
Revolutions per minute	500
Number of lamps in circuit	150
Average volts per lamp	47
Weight of armature complete	2,288
" " dynamo	14,600
" " " with sub-base	15,800
Temperature of field magnets after 10 hours' run	68° C
" " armature core " " "	95°
" " " wire	60°
" " room	27°
Watts output at full load, speed 500 r. p. m	67,680
Total watts generated	74,446
Commercial efficiency	90.91%

During the test of the machine the potential at the terminals was measured by means of two Weston voltmeters, specially designed for the purpose.

A combination gotten up to meet the requirements of the Detroit electric light plant is shown in Fig. 4, consisting of the new Wood machine coupled direct to a Willans high-speed engine.

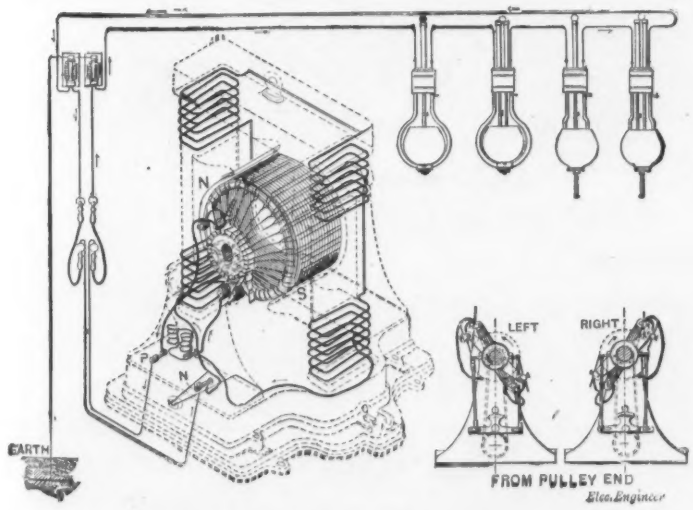


FIG. 3.—CONNECTIONS AND CIRCUITS.

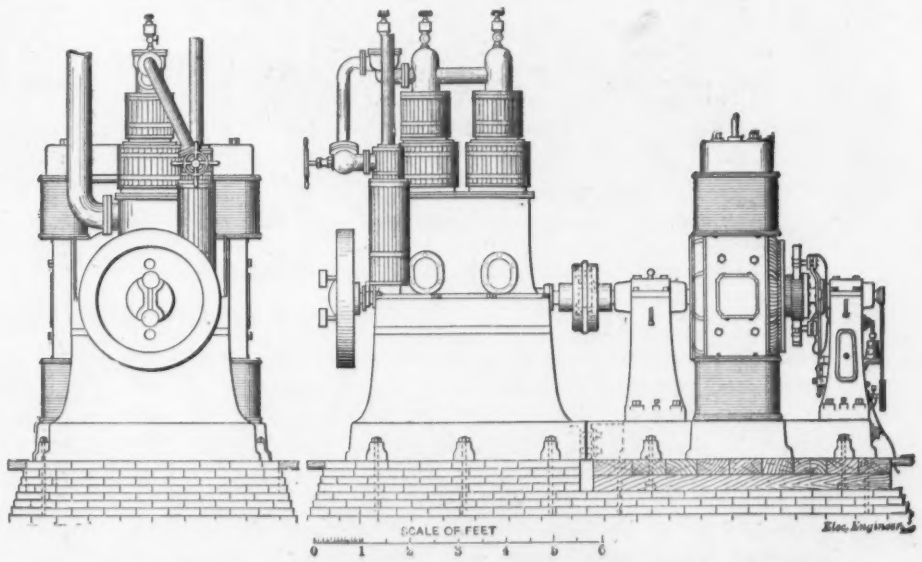


FIG. 4.—WOOD DYNAMO DIRECT CONNECTED TO WILLANS ENGINE.

Among the new auxiliary apparatus gotten up by the Fort Wayne company is the arc switchboard shown in Fig. 5. The plug sockets are mounted on marble bases, the line terminals above and the dynamo terminals on the lower board, with the voltmeter and ammeter and ground connec-

tions on the centre panel. This board embodies the ingenious devices of Mr. Wood, by which a circuit can be

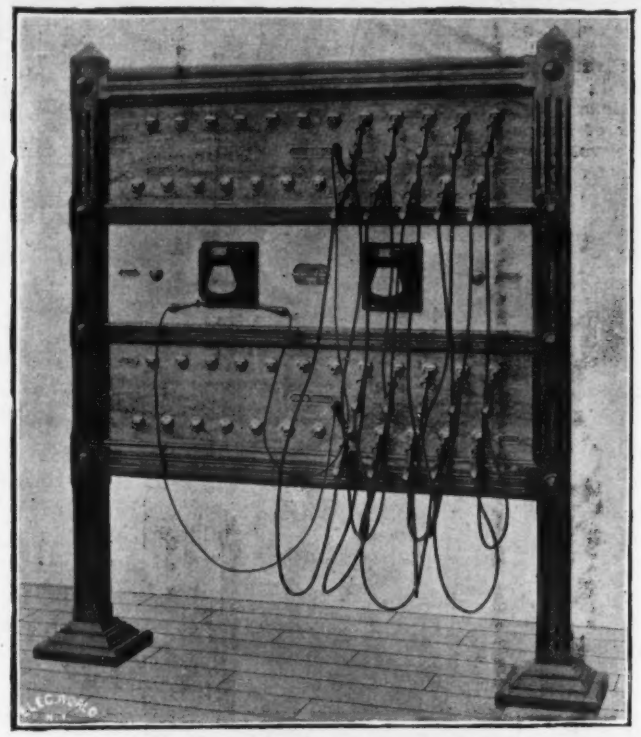


FIG. 5.—ARC SWITCHBOARD.

changed from one machine to the other without causing a break in the current.

Fig. 6 shows the Wood cut-out for arc work, which is so clearly represented as to require no further explanation.

Railway Car Electric Lighting.

For several years past efforts have been made to introduce electric lights for railway cars and many different devices have been brought forward. Simple storage batteries were first tried but failed to render satisfaction. The most extensively developed method of electric car lighting heretofore introduced provided a steam motor in the baggage car, fed by steam from the locomotive, by which a dynamo was driven to generate an electric current carried through the train by wires extending from car to car. This plan required the constant presence of an attendant and has been found so expensive as to be impracticable. A method providing a sprocket wheel attachment with the car axle driving a dynamo in a closet within the car and still another making connection with the car axle by means of a spiral spring band have also been tried.

Another device has recently been perfected and introduced into practical use by the American Railway Electric Light Company, Vanderbilt Building, New York, which, it is claimed, obviates the defects heretofore encountered. It provides a plain gear wheel attached to the car axle connecting by ordinary cogs with the shaft of the dynamo, which is securely placed on the car truck. By this means a constant and reliable electric current is generated, and by the utilization of a small storage battery the light is rendered uniform, both while the train is running and standing still.

Each car is thus independently provided with its generating and illuminating apparatus, so that cars may be detached from through trains when desirable and sent over connecting roads without limitation. All of the mechanism is securely placed beneath the floor of the car, completely incased to avoid dust and dirt, so that no space is occupied within the car. The apparatus is automatic in operation, thus requiring no personal attention, except at long intervals of time, when it will be regularly inspected at terminal stations. The dynamo used for this purpose is compound wound, with the compound winding used in reverse to the shunt, which acts as a governor when the higher speeds are reached, and keeps the E. M. F. nearly constant, so that if the dynamo is wound to give 30 volts and 35 amperes at 25 miles per hour, it will not vary 5 per cent. at 60 miles per hour. The system is automatic in all its movements, the current being taken care of by an automatic cut-out and pole changer combined, the pole changer device taking care of the direction in which the car is moving, and the cut-out taking care of circuits when the machine stops. A private car equipped with this apparatus recently completed a series of runs amounting to 4,332 miles, with, it is claimed, absolutely no cost for maintenance.

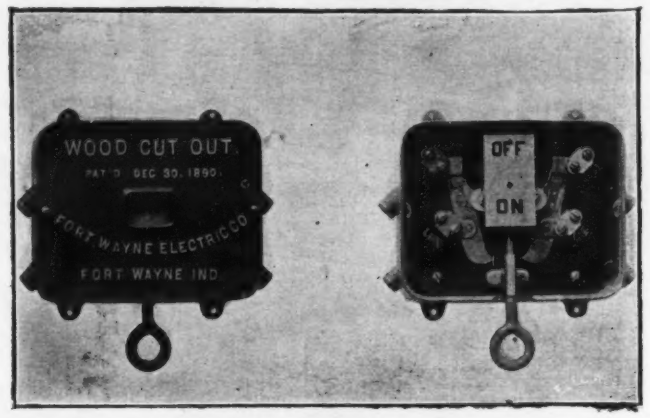
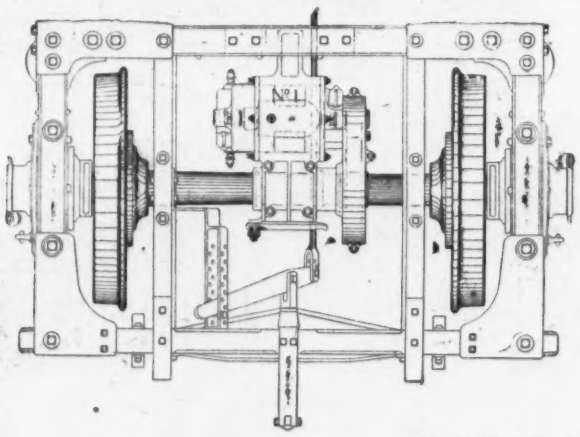
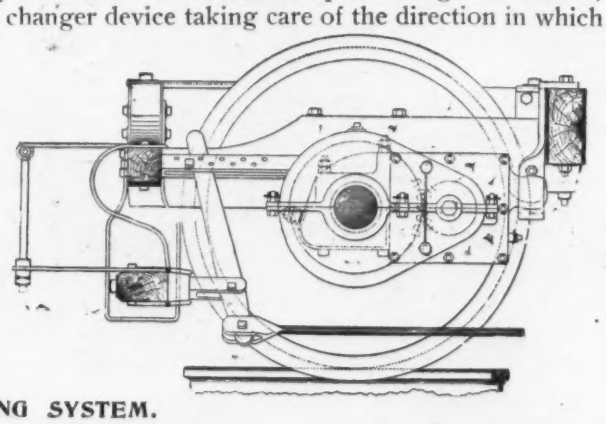


FIG. 6.—ARC CUT OUT.





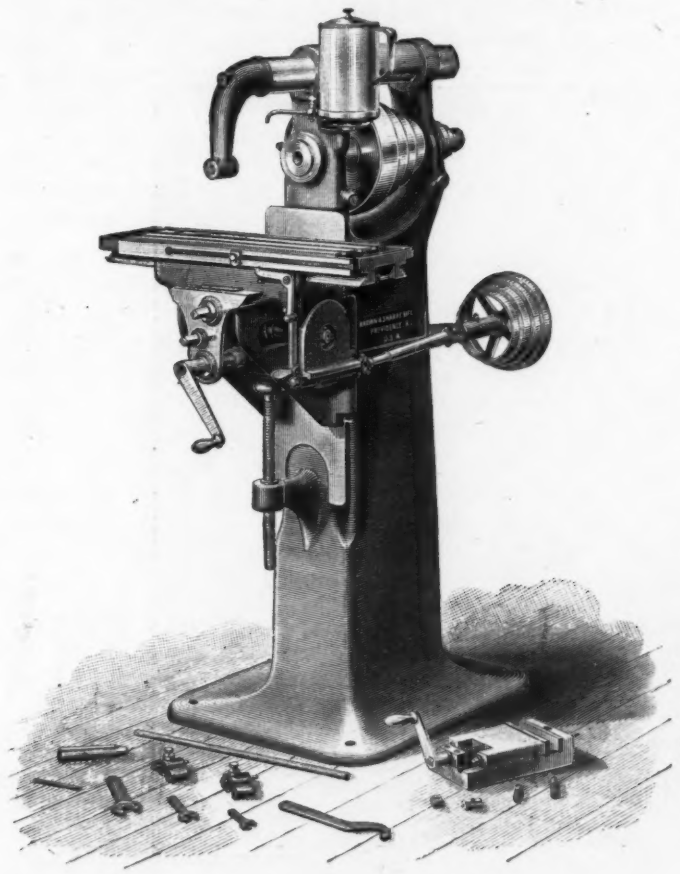
RAILWAY CAR LIGHTING SYSTEM.

Plain Milling Machine.

The machine we illustrate has just been placed upon the market by the Brown & Sharpe Manufacturing Company, Providence, R. I., and presents a number of new features, chiefly in connection with the feed. The straight bearings are scraped to surface plates, and the cylindrical bearings are ground and fitted to standards. The feed and elevating

screws are accurately cut, and the alignments are correct. The spindle has a hole its entire length and runs in bronze boxes provided with means of compensation for wear. The front end is threaded and has a hole fitted for arbors with taper 1-2 inch per foot and .9 inch diameter at the small end. The cone has four steps, the largest being 10 inches in diameter and for a 2 1-4-inch belt. The overhanging arm can be easily reversed to receive an attachment, turned out of the way, or removed. The distance from the centre of the spindle to the arm is 4 3-4 inches, and the greatest distance from the end of the spindle to centre of arm, 10 1-2 inches.

The table, including oil pans and channels, is 25 inches long, 8 inches wide and has a working surface 20 inches by 6 inches. It has also three T slots 1-2 inch wide, a transverse movement of 4 1-4 inches and can be lowered 12 inches from centre of spindle. The feed of table, 16 inches, is automatic in either direction, and there are eight changes of feed varying from .005 inch to .1 inch to one revolution of spindle. Adjustable dials graduated to read to thousandths of an inch indicate the transverse and vertical movements of table, and these dials may be adjusted without the aid of wrench or screwdriver. The frame is hollow and fitted as a closet to



PLAIN MILLING MACHINE.

hold the small parts that accompany the machine. On the left side there is a pan for holding small tools, etc., and on the front of this there is a rack for wrenches. The countershaft has tight and loose pulleys, and should run about 180 revolutions per minute. The weight of machine ready for shipment is about 1,085 pounds and the net weight about 770 pounds. The floor space occupied is 41 by 35 inches.

The Kennelly Combination Galvanic and Faradic Adaptor.

One of the most urgent inquiries of the physician of today is for an instrument which he can use with the Edison 110 or 120 volt direct current for all the varied forms of electro-therapeutic treatment with absolute safety to the patient, and at the same time be able to graduate and control it within the finest limits, and also accurately measure the strength of the current he is employing.

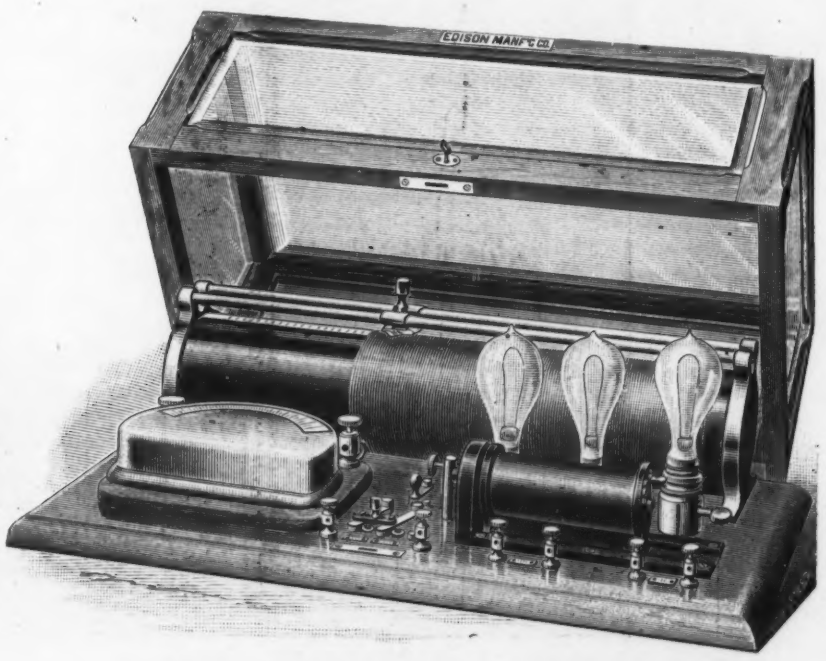
Such an apparatus is illustrated above, and has been designed by Mr. A. E. Kennelly (late chief electrician of the Edison laboratory), with a special view to fulfilling all these requirements, and is manufactured by the Edison Manufacturing Company, 110 East 23d street, New York.

It consists of a hard rubber cylinder, upon which is wound in suitable grooves, cut on the face of same, several hundred feet of German silver wire, having a very high resistance.

Near the end of the cylinder on the left, very high resistance carbon blocks are introduced into the circuit, making the total resistance about 33,000 ohms. This rheostat is regulated by the sliding contact, which travels along the two rods above and parallel with the cylinder.

A 16-c. p. lamp is placed in circuit with each of the leading-in wires to effectually protect the patient and apparatus should a short circuit occur on any part of the electric light circuit.

A third lamp, shown on the extreme right, provided with a key, is arranged in shunt with the rheostat. When the key is turned on, the voltage of the galvanic current is reduced to 60 volts. With this shunt in operation, and all the resistance of the rheostat thrown into the circuit by moving the sliding contact to the extreme left, a current of one milliampere is obtained when the binding posts are connected together by a short piece of wire, i. e., short circuited. On moving the sliding contact to the right, the resistance is very gradually diminished, and the current correspondingly increased. This finely graduated current is required in some cases, where a



GALVANIC AND FARADIC ADAPTOR.

very slight irregularity in the current would produce a shock to the patient.

When a stronger current is required, the lamp is cut out by turning off the key and the current is used unshunted.

The well-known Kennelly milliammeter is mounted on the base on the left, the pole changing switch is placed in the middle of the board, while on the right is shown the faradic coil, which is also operated by the street current.

This is of the Du Bois Reymond type, the secondary being wound upon a separate spool, removable at will. This secondary winding consists of 18 layers of No. 34 wire, having a total length of about 1,800 yards. The winding is tapped in six places, so as to divide the coil into six sections, each section consisting of three layers of wire, the whole being connected in series.

By this arrangement 3, 6, 9, 12, 15 or 18 layers of secondary winding can be used as required, by moving the switch shown on the end of the coil.

Each section produces an entirely different sensory effect, the current in the first section being very stimulating, whereas the current in the sixth section is of a very pleasing character and produces a sedative effect; the character of the currents in the other sections being intermediate between the two extremes. When first put into operation, the secondary coil should always be moved to the extreme right, so as to leave the primary uncovered, the strength of the current being increased by slowly moving it toward the left, so as to finally cover the primary coil.

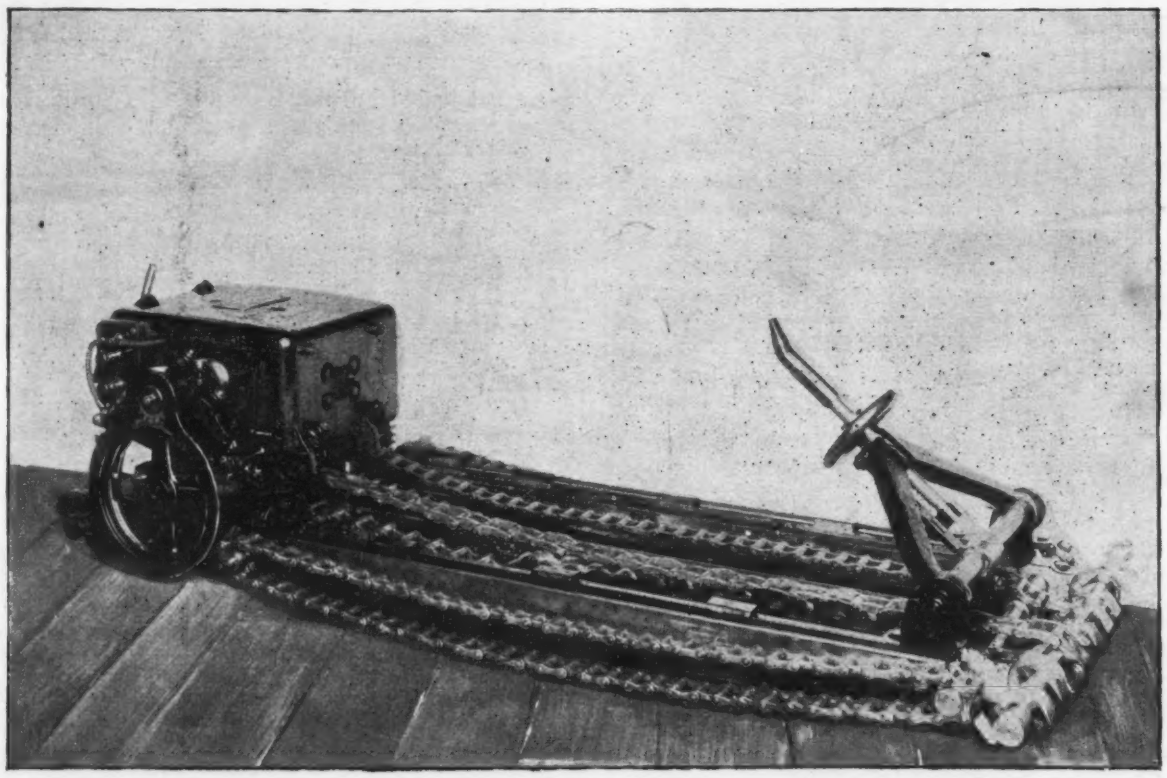
The current in the primary, on the contrary, is at a minimum when it is entirely covered up by the secondary coil, which in this case must be short circuited by a switch provided for that purpose, and it is increased by sliding back the secondary coil to the right.

When the switch at the back of the pole changing switch is turned on and the vibrator set in motion, the current from the galvanic binding posts is of a pulsating character, as the primary of the faradic coil is superposed on the straight galvanic current, thereby producing the pulsating current as described by Dr. De Watteville. The strength of these two combined currents is controlled by the rheostat in the ordinary way. It is thus possible to obtain from this instrument: First, the direct galvanic current of 120 volts; second, the direct galvanic current of 60 volts; third, the primary faradic current capable of six variations of strength, depending upon the number of sections of the secondary coil that are short circuited; fourth, the six secondary faradic currents, all of which manifest distinct characteristics; fifth, the primary faradic current superposed on the 120-volt galvanic current; sixth, the primary faradic current superposed on the 60-volt galvanic current.

Electric Coal Cutter.

The illustration shows a new and improved device for cutting coal, which has just been designed and perfected by the General Electric Company. It is known as R. B. 40, and is of the rotating bar type. It consists principally of a bed frame of two steel channel bars firmly braced. Mounted upon and engaging with this bed frame is a sliding frame similarly braced, consisting of two steel bars, at the rear end of which is mounted an ironclad multipolar electric motor communicating power to the feed and driving mechanism. The front end of this sliding frame carries the cutter bar, in which the cutters or bits of tool steel are held by set screws. When the cutter bar is revolved, these cutters or bits cover its entire face. The bar is driven by an endless chain, and as it is revolved is advanced by the feed mechanism into the coal or other material to be cut, to the desired depth, and the cuttings are brought out to the face of the coal by means of cleaning chains.

This machine is operated by two men, one in charge of the machine and the other as a helper. A carriage is furnished with the machine, which enables it to be handled with ease. The machine is taken into the mine on this carriage and run into the room to be under-cut. It is then placed on two skid boards in front of the coal at one side of the room or entry to be under-cut; and it is fastened firmly by means of the front and rear jacks, which are braced against the face and roof of the coal. These prevent the machine from moving when in operation. The power is then turned on by the attendant, and the machine proceeds to do its work.

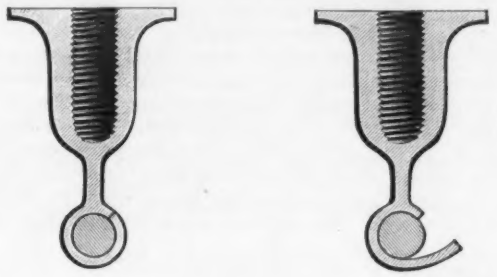


ELECTRIC COAL CUTTER.

The cutter bar, which is revolved by an endless chain, is fed forward to a depth of five or six feet, according to the size of the machine. The usual length of the cutter bar is 39 inches, but 42 or 48 inch bars can be used where the cutting is not too hard. When the fuel depth is reached the feed is thrown off, and by means of a reverse lever the cutter bar is withdrawn to its starting point and automatically stopped. This completes the cut, and the machine is moved over the length of the cutter bar used and another cut made in the same manner. This is continued until the entire width of the run or entry is under-cut, after which the machine is again loaded on the carriage and taken into another room.

The cuts are made in the short space of time of from four to six minutes. The amount of coal under-cut, or the lineal feet face for each machine, depends upon the quality of the

coal and the skill of the man handling it. The construction of this machine is extremely simple, and any person of ordinary intelligence can understand and handle it with a few days' instruction. All parts are made in duplicate and are interchangeable.

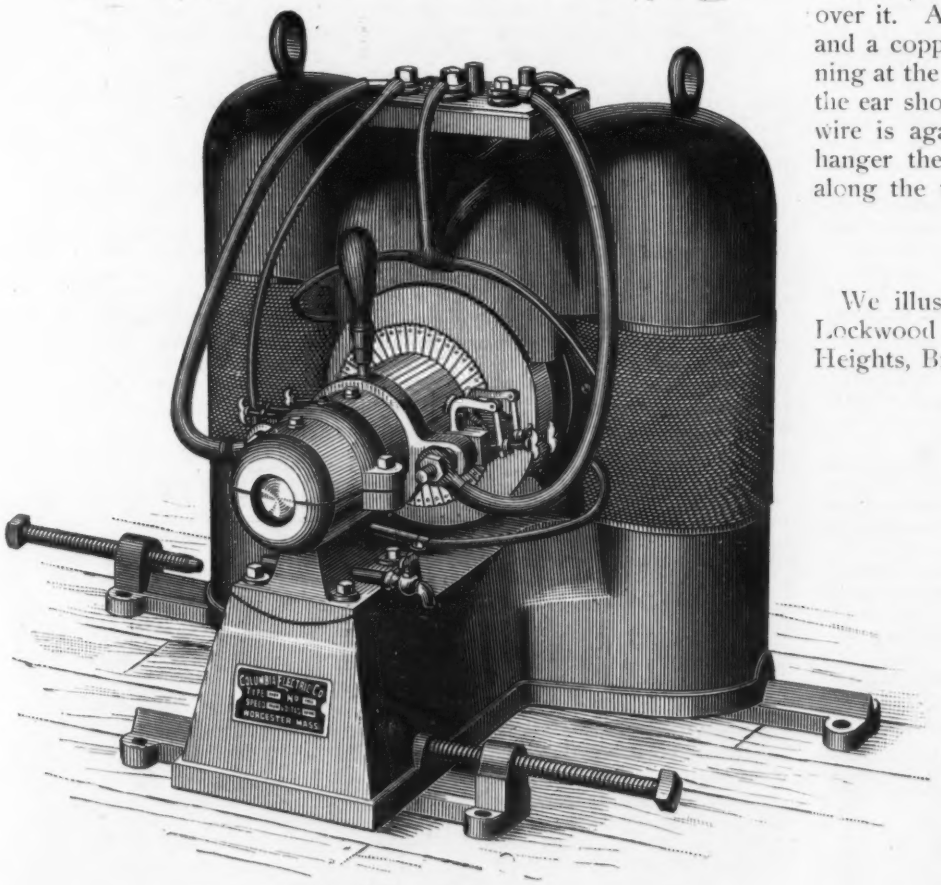


THE SPILLMAN TROLLEY EAR.

The Columbia Dynamo.

We illustrate herewith the new type dynamo which the Columbia Electric Company, Worcester, Mass., is placing on the market.

The dynamo has consequent poles, with massive cast iron fields and wrought iron cores. The armature is of the Gramme ring type. The commutator is built of tempered copper and is very large. The brush holders are so arranged that carbon or woven wire brushes may be used. The fields are compound wound, and so proportioned that the potential between the brushes remains practically constant through all variations of load. The bearings are of the spherical type, so that they are self-aligning and self-adjusting, and are lubricated by means of ring oilers.

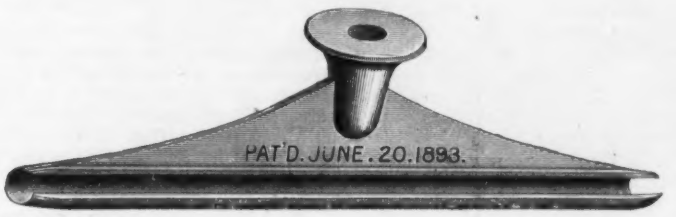


COLUMBIA DYNAMO.

As will be seen from the cut, the dynamo is very compact and substantially built, with well proportioned fields. The company is at work developing some cast steel magnets for the same type. It has also on the market a dynamo whose fields are composed of wrought iron forgings.

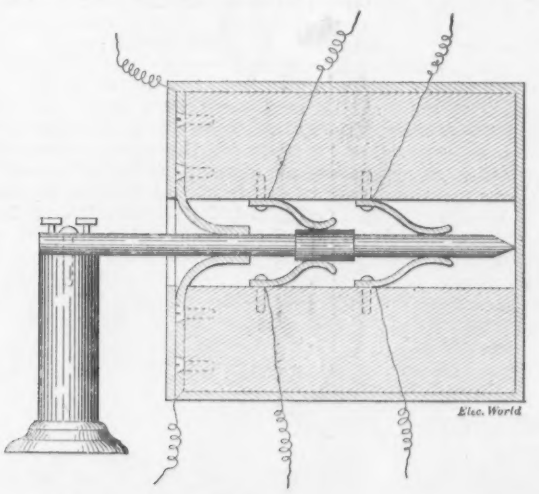
The Spillman Trolley Ear.

The accompanying cuts show different views of the Spillman trolley ear, which the Ohio Brass Company, of Mansfield, O., has recently made extensive arrangements to manufacture and is now offering to the trade. The ear has several features peculiar to itself which commend it to the users of similar devices. It is safe to say that the Ohio Brass Company will find a large sale for them. The great objection raised to the use of soldered ears, namely, that of burning the trolley wire, the time and material consumed in soldering, the difficulty of adjusting the hanger after once in place, as well as the objection to many clamps, that of sparking when the trolley wheel passes over it, have all been overcome in the design and construction of this ear. It has been given a practical test both on straight line and curve work for over a year past on one of the largest roads in the West, and its utility thoroughly demonstrated. The ear is screwed on to the hanger body and the trolley wire placed in the concave lip. The trolley wire is then pulled to the necessary tautness and the lip of the ear is compressed over it. A metal block is held on the back side of the ear and a copper hammer used to do the forming with, beginning at the centre and working toward the ends. On curves the ear should be hung so that the side strain of the trolley wire is against the web. If it is necessary to adjust the hanger the lips can be opened sufficiently to slip the ear along the trolley wire.



Telephone Switch.

We illustrate herewith a telephone switch made by the Lockwood Electric Telephone Company, 18 Columbia Heights, Brooklyn. Secured to the receiver is a rod of hard rubber with a metal sleeve about midway of its length. When the receiver is not in use, the rod is in the opening shown, the transmitter and receiver circuits, connected with the extreme contacts, are open and the central or call circuit is closed by the metal sleeve. When the telephone is in use, the central or call circuit is open and the two others closed.



TELEPHONE SWITCH.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, June 16, 1894.

GENERAL ELECTRIC, being a stock wherein traders have always hitherto discovered the most profitable opportunities for reaping a profit on one or the other side of the stock market, maintains its position as the most conspicuous of all stocks of its particular group. At several times during the financial week ending to-day it has displayed activity particularly pleasing to the friends of the property, and the advance has been held rather well. Opinion is divided as to whether most of the buying bringing about this week's advancing quotations has been for the account of the bull pool mentioned as operating in this specialty in last week's correspondence, or for the purpose of covering short contracts put out around 32, just before the last annual meeting. Suffice it to say that good buying of some sort or another has been noticeable all week long.

THE WESTINGHOUSE ELECTRIC COMPANY seems to be genuine in its determination to secure the lion's share of the electric light and power business in this section. Bearing out the announcement made in these columns last week comes the information that the United States Electric Company, of New York, the Westinghouse's local representative, has increased its capital stock from $5,500,000 to $6,000,000, the amount of capital actually paid in being about $3,000,000, while debts and liabilities are figured at the same amount. The new capital represents increased valuable plant, wherewith inroads are to be made on rival's territory. The business of the company continues growing.

EDISON ELECTRIC ILLUMINATING COMPANY, of New York, has made a statement of comparative earnings. The net earnings for May, 1894, were $46,864.93, an increase of $9,477.68 over those of last year. The gross earnings for the five months ending May 31, 1894, were $586,403.35; net earnings $323,140.48, an increase of $75,035.59 over 1893. Trading in the stock has been rather light and quotations remain steady.

EDISON ELECTRIC ILLUMINATING COMPANY, of Brooklyn, reports a net increase in May earnings of $2,683. The gross earnings since Jan. 1, 1894, were $84,683, an increase of $20,386. The company is now taxed to its utmost capacity to supply the demand for light. It is erecting 700 ornamental arc light poles for Brooklyn city lighting, besides its usual increase every month of incandescent lamps.

THE CHICAGO EDISON ELECTRIC ILLUMINATING COMPANY makes a good showing in its annual report. The statement was for the 15 months ending March 31, 1894, and shows that 50,000 new lights were connected during that period, making a business increase of 20 per cent. The gross income was $2,141,779; expenses, $1,461,102; net income, $680,677. The company has accumulated a surplus of $254,260 from these earnings. The stock continues in high favor by investors, though it is not quoted at figures which the earnings of the company warrant. At the annual meeting, recently held in Chicago, the old board of directors was re-elected.

WESTERN UNION TELEGRAPH has rather surprised Wall Street in its quarterly statement ending June 30, and in the declaration of a 1¼ per cent. dividend. It was the general opinion of the Street that this quarter's dividend would be reduced, as preceding quarterly reports have shown a big decrease in earnings. As it is, the report shows a decrease of $300,000 in the net revenue, as compared with a like period for 1893, and a decrease in surplus after dividends of $300,277. This quarter's report, however, indicates an increasing business for the three months ending June 30 over that of the preceding quarter, and has earned enough money to pay the usual rate of dividend and leave a surplus of $21,138.

AMERICAN BELL TELEPHONE COMPANY has declared its regular quarterly dividend of $3 per share, but the expected $3 per share extra was passed. This has caused the stock to drop several points, and started every one at guessing the reason for no extra. It is the first July since 1888 that the Bell Telephone Company has failed to pay an extra dividend, so that it naturally had an adverse effect upon the stock.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Western Union Telegraph		84¾	85
American Bell Telephone		196½	196
Detroit Electrical Works	10	3	4
Cleveland General Electric Co.	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref.	15	15	16
" " " com.	15	15	17
Edison Electric Ill., New York	100	99½	100½
" " " 1sts.	—	106½	107
Edison Electric Ill., Brooklyn	100	101	102
" " " Boston	100	117	118
" " " Chicago	100	125	130
" " " Philadelphia	100	130	132
Edison Electric Light of Europe	—	—	2
" Bonds	—	80	85
" Ore Milling	—	10	13
Fort Wayne Electric	—	1	2
General Electric Company	100	36½	36⅝
" " " deb. 5's	—	86	86½
Interior Conduit and Ins. Co.	100	45	65
Mount Morris Electric	—	—	55
Westinghouse Consolidated	50	36½	37
" " " pref.	50	51½	52

New Incorporations.

THE FORT WAYNE ELECTRIC CORPORATION, Fort Wayne, Ind., has been incorporated.

THE ELECTRICAL CONTRACTORS' EXCHANGE (Protective), Detroit, Mich., has been incorporated.

THE ELECTRO-CHEMICAL COMPANY, Rumford Falls, Me., capital stock $800,000, has been incorporated.

THE STEEN'S CREEK TELEPHONE COMPANY, Steen's Creek, Miss., capital stock $5,000, has been incorporated.

THE CUYAHOGA SUBURBAN RAILWAY COMPANY, Cleveland, Ohio, capital stock $10,000, has been incorporated.

THE INTERNATIONAL TELEPHONE CONSTRUCTION COMPANY, Chicago, Ill., capital stock $200,000, has been incorporated.

THE CHICAGO SUBURBAN ELECTRIC COMPANY, Chicago, Ill., capital stock $1,000,000, has been incorporated by Ralph H. Bradley and others.

THE PITTSBURGH AUTOMATIC LIGHTING COMPANY, Pittsburgh, Pa., capital stock $10,000, has been incorporated by C. H. Covell and others.

THE ECONOMIC ENGINE COMPANY, Chicago, Ill., capital stock $100,000, has been incorporated to manufacture and sell electric motors, engines, etc.

THE McDERMID MANUFACTURING COMPANY, Chicago, Ill., capital stock $5,000, has been incorporated to manufacture annunciators, electrical specialties, etc.

THE STANSTEAD ELECTRIC LIGHT COMPANY, Stanstead, Quebec, has been incorporated with a capital stock of $25,000, to use electricity for commercial purposes.

THE SIOUX CITY TRACTION COMPANY, of Sioux City, Iowa, capital stock $1,000,000, has been incorporated to operate street railways, electric light and steam heating plants.

THE CARROLL COUNTY ELECTRIC LIGHT AND POWER COMPANY, Westminster, Md., capital stock $5,000, has been incorporated by Milton Schaeffer and others, and will erect an electric light and power plant.

BERKELEY, CAL.—The Berkeley Electric Lighting Company has been organized to generate, transmit, distribute and sell in Berkeley electricity for all purposes for which it may be used. The capital stock is $100,000. J. George Gardner, C. K. Clark and Walter S. Sell are interested.

THE LEAVENWORTH ELECTRIC RAILROAD COMPANY, Leavenworth, Kan., capital stock $300,000, has been incorporated. W. D. Bethel, Memphis, Tenn.; H. N. Smith, Boston, Mass.; Newman Erb, New York; J. P. Edrington, Denver, Colo.; M. Summerfield, Lawrence, Kan., and others are interested.

THE ROXBOROUGH, CHESTNUT HILL AND MORRISTOWN TRACTION COMPANY, Philadelphia, Pa., capital stock $5,000, has been formed to construct and operate motors and cables and other machinery for supplying motive power to passenger railways. The promoters are W. H. Heulings, Jr., J. T. Dunlap and H. C. Ealing, all of Philadelphia, Pa.

NEW HAVEN, CONN.—The certificate of organization of the Connecticut Electrical Company, of New Haven, Conn., has been filed with the State Secretary. The company is organized to operate telegraph, telephone, electric light and power lines. The capital stock of the corporation is $10,000 in 400 shares of $25 each. Twenty per cent. of the capital has been paid in cash.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, June 18, 1894.

THE PARK DEPARTMENT will install an electric light plant in the addition to the American Museum of Natural History. Bids will be opened June 20.

MR. WM. R. GOODMAN, of the Independent Electric Company, Chicago, was in town last week, and reports a flattering demand in the East for the tested fuse wire and links manufactured by his company.

THE CONEY ISLAND, FORT HAMILTON AND BROOKLYN RAILROAD COMPANY has filed with the Secretary of State at Albany a certificate for an extension of its route in Kings County, commencing at Fifth avenue.

AN ELECTRICAL THEATRE is to be erected on Culver Plaza, opposite Chambers' drug store at Coney Island. It will seat 750 people, and will exhibit the same features as that of the Western Electric Company at the World's Fair.

THE FORT WAYNE ELECTRIC CORPORATION, which has leased from the receivers the factories of the Fort Wayne Electric Company, has located its New York offices at 115 Broadway, where Mr. R. T. McDonald will be pleased, when in town, to meet his friends.

MR. AVERY P. ECKERT has been appointed travelling representative of the Safety Electric Wire Company, of this city, and will shortly make a trip in the interest of their excellent wire and cable.

Mr. Eckert is well known among electrical supply houses, architects, etc. He is the son of Mr. W. H. Eckert and nephew of Gen. Thomas T. Eckert.

A GOOD START has been made toward laying the foundations for the power station of the Nassau Electric Railway Company, of Brooklyn, and the track and overhead construction are progressing rapidly. The company has already received several large shipments of trolley line insulators from the H. W. Johns Manufacturing Company, of New York.

N. M. GARLAND, of 120 Liberty street, this city, the general Eastern representative of the Emerson Electric Manufacturing Company, reports that despite the backward season, the sale of the "Meston" fan motors has been very large. The '94 model of this motor has many improvements, and has added considerably to the reputation of this popular fan.

MR. IRA W. HENRY, the electrician of the Bishop Gutta Percha Company, was married on June 6, 1894, in St. Agnes' Chapel, to Miss Frances Scrivener. A large gathering of friends witnessed the ceremony and expressed their hearty congratulations. The couple immediately started on a Southern trip. Capt. W. Walcott Marks, superintendent of the Bishop company, officiated as the best man, and Mr. Harry D. Reed acted as usher.

ERASTUS WIMAN, who was last week found guilty of forgery in the second degree, has for some years been identified with telegraphic and other electrical interests, notably in connection with an extensive system of electric lighting on Staten Island. At one time he occupied an important position in the direction of the Western Union, from which he was retired on account of his equivocal methods of obtaining information relating to a rival company.

THE CLEVELAND GENERAL ELECTRIC COMPANY has passed into the hands of a New York electric syndicate, all its obligations being assumed, and its stock, it is said, being taken up at par, minus brokers' commissions. Extensive improvements will be made in the local plant involving an immediate outlay of between $400,000 and $500,000. The local company will be known as the Cleveland Electric Illuminating Company, and James Parmalee will be president.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 16, 1894.

THE NEW YORK INSULATED WIRE COMPANY has removed its New England Department to 134 Congress street, Boston, of which Mr. Walter S. Barker is in charge.

MESSRS. LINTON & SOUTHWICK, of Worcester, Mass., report the demand for their switches as being so great just now as to require them to run their factory on 15 hours' time per day.

MR. C. J. H. WOODBURY has resigned the vice presidency of the Boston Manufacturers' Mutual Fire Insurance Company, to take effect Sept. 1, on which date he will enter the service of the American Bell Telephone Company.

BOSTON INCANDESCENT LAMP COMPANY.—Judge Colt, of the United States Circuit Court, at Boston, rendered last Monday an opinion restraining this company from manufacturing incandescent lamps, and in favor of the Edison Electric Light Company.

THE AUTOMATIC SWITCH COMPANY, Baltimore, Md., has appointed the following agents: Boston Electric Company, 548 Washington street, Boston, Mass.; Michigan Electric Company. 47 State street, Detroit, Mich.; Duquesne Electric Supply and Construction Company, 709 Lewis Block, Pittsburgh, Pa.

THE BILL relative to the inspection of electric light meters has been reconsidered by the Massachusetts Legislature, notice being given that an amendment would be substituted, requesting the gas and electric light commissioners to investigate the working of meters and report their findings to the next general court.

ANDOVER, MASS.—Alvin T. Morrill, of this city, has been appointed receiver for the Craighead & Kintz Company, in the Supreme Court, by Judge Barker. The company was organized with a capital of $250,000, and engaged in the manufacture and sale of electric and kerosene lighting apparatus and fancy metal goods, with a factory at Andover. The assets are inventoried at $300,000, and the liabilities are less than $70,000.

MR. GEORGE NICHOLS SARGENT, of Melrose, Mass., and junior member of the firm of Almon & Sargent, electrical engineers and contractors, of Boston and New York, was married on the 11th inst. at the Cathedral rectory, in Boston, to Miss Alice Adelaide Proctor Poor, daughter of John A. Poor, Esq., the well known coffee broker of Albany, N. Y. We join in congratulations with Mr. Sargent's numerous friends, and wish for the happy couple a life of uninterrupted happiness and prosperity.

THE ELECTRIC POTENTIAL.—Boston's new electric club met at Young's Hotel last Wednesday evening for the purpose of enjoying another dinner and listening to an instructive address on "Electrolysis of Pipes and Cables," by Mr. I. H. Farnham, of the American Bell Telephone Company. Fifteen new names were added to its membership, and 25 members attended this meeting—facts which argue future prosperity for this new organization. Mr. Farnham's address commanded the close attention of all present, and while in great measure it was a repetition of his utterances recently before the American Institute of Electrical Engineers, he introduced several new ideas and observations. Mr. Farnham presented about 50 stereopticon views, showing cables, gas and water pipes destroyed by the action of electrolysis, and diagrams showing the proposed methods of remedying the evils and the danger districts around Boston before and after improvements had been effected. The most interesting part of his address was a model showing the action of electrolysis. President C. W. Holtzer presided over the meeting.

Canadian Notes.

OTTAWA, Ont., June 16, 1894.

MONTREAL.—The street railway company has placed a number of new open cars on the streets. There are 15 similar ones being made. The cars were constructed by the Ottawa Car Company. The making of these cars outside the city, it is held, is tantamount to the annulment of the company's contract.

OTTAWA, ONT.—The Bell Telephone Company's underground cable will be laid in a few days. Eighteen thousand feet of underground cable and 19,000 feet of aerial cable will be laid and strung. The underground cables are heavily encased in lead. Each of these cables contain 100 pairs of wires. The cables are 2 5-16 inches in diameter, and weight five pounds per foot.

OTTAWA, ONT.—Thos. Todd, president of the Galt and Preston Street Railway Company, stated at a recent meeting of the directors that the contract for dynamos, motor cars, overhead work, bolting rails, etc., had been awarded to Messrs. Ahearn & Soper, of Ottawa, at the sum of $15,925, and the contract for engines and boilers to the Goldie & McCulloch Company, of Galt, at $6,000.

MONTREAL.—The Montreal Street Railway is said to have a great scheme on foot, which, if carried into effect, will necessitate an enormous outlay of money. Owing to the rapid growth of the city the company has for some time contemplated the erection of a large power house and yards in a central part of the city. The only site which is said to be desirable for the project is the large square bounded by St. George, Vallee, Philip and Dorchester streets. Some of the proprietors have been waited on, and offers made for their properties. If the scheme is carried out, an immense power house will be built on a portion of the ground. The remaining sections will be utilized for tracks and running sheds for the electric cars.

News of the Week.

Telegraph and Telephone.

WHEELOCK, TEX.—Mitchell Bros. & Decherd will construct a telephone line to Franklin.

AUGUSTA, GA.—Jacob Edmunds is reported to be organizing a $10,000 telephone company.

DANVILLE, VA.—Address W. A. Taylor concerning a $10,000 stock company organizing to construct a telephone system.

PALESTINE, TEX.—L. C. Ketchum has been granted a 15-year franchise for a telephone system, and will construct it immediately.

SALISBURY, MD.—The Salisbury Telephone Company will purchase 10 miles of telephone wires, 50 instruments, etc. A. J. Benjamin is president.

SCRANTON, VA.—Address Clemmer & Hogshead concerning a company organizing with a capital stock of $5,000, to establish a telephone line to Middlebrook.

WHITE RIVER JUNCTION, VT.—A new telephone exchange is to be located at White River Junction by the New England Company, and will include all the surrounding towns. It will be equipped with long distance phones.

LEXINGTON, VA.—A company has been organized to erect a telephone line between Staunton and Middlebrook. J. H. Bowman is president. This company will possibly, in the future, extend its line to Greenville, Moffett's Creek and Lexington.

HUNTSVILLE, TENN.—James E. Caldwell, president, and Leland Hume, general manager, of the Cumberland Telephone Company, of Nashville, were in the city looking into the building of a long distance line from this city to Nashville.

Electric Light and Power.

FLEMINGTON, N. J.—Flemington will establish an electric light plant.

GENESEO, N. Y.—Ground has been broken for the electric light plant in this village.

EAST TROY, WIS.—East Troy is considering the cost of an electric lighting plant.

MORRISTOWN, N. J.—Bound Brook has a newly organized electric light company.

NANTUCKET, MASS.—The Nantucket Electric Light Company is advertised to be sold under foreclosure.

QUITMAN, GA.—The town will issue $20,000 in 6 per cent. bonds for putting in electric light and waterworks.

NIAGARA FALLS, N. Y.—The Niagara Falls Electric Light and Power Company has increased its capital stock from $40,000 to $75,000.

BROOKLYN, N. Y.—The Brooklyn Common Council has granted franchises to the State and Kings County Electric Light and Power companies.

GENESEO, N. Y.—The electric lighting company of Geneseo will soon build its power house on the company's lot, north of the gas house.

LAFAYETTE, IND.—The Thiemes-Wagner Company will erect new buildings at its brewery plant, and an electric lighting machine will be put in.

WASHINGTON, D. C.—Address S. Wike, acting secretary of the treasury, until July 9 concerning bids for combination gas and electric light fixtures for public buildings at Duluth, Minn.; Galesburg, Ill.; Jackson, Mich, and Paris, Tex.

MILWAUKEE, WIS.—City Clerk Anderson sent a circular letter to 122 cities in the United States in which the electric lighting plant is owned by the municipality. He inquires as to the cost and other particulars regarding the operation of the plants.

PENSACOLA, FLA.—The Citizens' Electric Light and Power Company has organized with a capital stock of $20,000, and will at once begin the erection of a plant. T. E. Welles is president, C. J. Heinberg, secretary and treasurer, and W. B. Crossand, general manager.

ROCHESTER, N. Y.—Acting on a recent resolution of the Common Council, the lamp and electric committee of the Council has decided to advertise for bids for the lighting of State street in a similar manner to that employed on East Main street, where lamps are now being placed.

ALBANY, N. Y.—The United Electric Light and Power Company, of New York, certifies that it has increased its capital stock from $5,500,000 to $6,000,000. The amount of capital actually paid in is $2,049,600, and the amount of the company's debts and liabilities is $2,946,570.

THE FRANKLIN ELECTRIC LIGHT COMPANY, Franklin, Ohio, will soon be in the market for some slow speed motors of about 40 h. p. capacity each, to be used for the operation of some power pumps, and will furnish specifications of the requirements necessary to be fulfilled.

PITTSBURGH, PA.—The Alleghany sub-committee on public lighting met June 6, and recommended to councils that the bid of R. C. Tannehill, for the erection of an additional electric light plant on Braddock street, be cut $4,500 that it may come within the limits of the appropriation.

LEWISTOWN, PA.—The Logan Iron Works, situated in Mifflin County, Pa., about one and a half miles northeast of Lewistown, has commenced the erection of its new buildings recently destroyed by fire. It is the intention to equip the new mill with an electric crane and all the latest labor-saving appliances.

CHAPPAQUA, N. Y.—A franchise has been granted to G. H. Selleck & Co., electrical contractors, 66 West 132d street, New York, to erect and maintain an electric light and power station in the villages of Unionville, Sherman Park, Pleasantville, Chappaqua and Mount Kisco. The plants will be constructed and operated by the firm named.

HOPKINSVILLE, KY.—The city clerk of Hopkinsville, Ky., will receive sealed bids for lighting the city by electricity with not less than 35 arc lights of 2,000 c. p. each, all night and every night lighting, for a period of not less than one nor more than five years from Aug. 22, 1894. Said bids to be filed with W. H. Tibbs, city clerk, on or before July 3, 1894.

ST. BERNARD, OHIO.—Sealed proposals will be received until July 7 for the furnishing and erection of boilers, engine, countershaft, belts, etc., for an electric light plant, the furnishing and erecting of dynamos and apparatus for the production of and operation of arc and incandescent lights. Herman J. Witte, John A. Larkin and Henry Imwalle are the board of trustees. George Hornung, 30 East Fourth street, Cincinnati, Ohio, is consulting engineer.

UNION, MO.—The electric lights were successfully started on the evening of June 6, the event being made the occasion of a great celebration. This plant, which was designed by William H. Bryan, consulting engineer, of St. Louis, presents some novel features. The lights are operated from Mr. A. A. Tibbe's Westinghouse station at Washington, Mo., 10 miles distant. The current used on the primaries in Washington and Union is 1,000 volts alternating. At Washington a step-up transformer is used, raising the voltage to 4,000, and the current is then transmitted over a pair of No. 3 wires, a step-down transformer being located at the entrance to the town of Union. The service in Union consists at present of 250 16-c. p. commercial lights, and five 50-c. p. and 16 32-c. p. street lamps. Although Union is a town of less than 1,000 inhabitants, and the consumption of light there is necessarily limited, the recent advancement in transformer construction and the low cost of copper have made it possible to handle this service profitably from the Washington plant. It is estimated that with the average load, the losses due to transformation and transmission will not exceed 5 per cent.

The Electric Railway.

WATERLOO, N. Y.—The Canandaigua street railway is being converted into an electric road.

CHEVY CHASE, MD.—The Chevy Chase Electric Railroad is to be extended to Kensington, Ky.

BUFFALO, N. Y.—An electric railway between Randolph and East Randolph is being talked of.

BOSTON, MASS.—An electric railway connecting Hartford and Rockville is to be built this summer.

EAST WEYMOUTH, MASS.—The new electric railway from North to East Weymouth has been opened for operation.

SUSQUEHANNA, PA.—A charter has been granted the Honesdale Electric Railway Company, with a capital of $50,000.

STAUNTON, VA.—Address secretary of Chamber of Commerce concerning proposed electrical railroad from Staunton to Monterey.

LYNCHBURG VA.—C. S. Hutter may be addressed concerning the proposed electric railroad from Lynchburg to Bedford City, Va.

WASHINGTON, D. C.—Address the Columbia Railway Company concerning an underground cable for the propulsion of its cars.

VELASCO, TEX.—Address W. A. Rowan concerning proposed electric railroad to connect the Sante Fe and Velasco Terminal railways.

NIAGARA FALLS, N. Y.—The contract for the new electric railroad at the north end of the city has been let to J. W. Hoffman & Co., of Philadelphia.

ROCHESTER, N. Y.—A certificate of lease of the Cayuga Lake Electric Railway to the Ithaca Street Railway Company has been filed with the Secretary of State.

TERRE HAUTE, IND.—The Terre Haute Electric Railway Company has been organized with a capital of $500,000. The directors are P. P. Thomas, J. G. McNutt and M. F. Burke.

BALTIMORE, MD.—The Hall's Spring electric line of the Baltimore City Passenger Railway Company will be extended to Clifton as soon as the rights of way are secured from the city.

ALBANY, N. Y.—It is said that about $350,000 will be required to build and equip the proposed electric road between Amsterdam and Gloversville. If Amsterdam will take $50,000 of the stock the road will be built.

HOUTZDALE, PA.—Messrs. Seeley & Barret, of Hazleton, Pa., will build a new railroad from Phillipsburg to Ramsey immediately, making Houtzdale the main point, and eventually it will be built to Clearfield and Curwensville.

POUGHKEEPSIE, N. Y.—The contract for trolley line insulators has been awarded to the H. W. Johns Manufacturing Company, New York, by the Poughkeepsie and Wappinger Falls Railway Company, shipments to begin immediately.

BOSTON, MASS.—The South Side Street Railway Company, which proposed to build a route from Lowell to Lawrence, has withdrawn its petition for a location there, owing to the refusal of the Lowell aldermen to grant right of way in that city.

CINCINNATI, OHIO.—The commissioners of Butler County granted a 50-year franchise to the Hamilton, Lesourdsville and Middleton Electric Railway Company for a road between Hamilton and Middleton. Eastern capitalists are behind the movement.

ST. LOUIS, MO.—The Lindell Railway Company has been granted permission to build a one-story brick power house, costing $46,000, on the north side of Park avenue, between Vandeventer avenue and Lawrence street. The office is at 2330 Choteau avenue.

PHILADELPHIA, PA.—An ordinance has been passed authorizing the Union Passenger Railway Company and its lessee to make further extensions, and to use electric motors, to be supplied from overhead wires, and to erect and maintain poles to support the same.

BRADFORD, PA.—A charter was issued June 7 by the State department to the Bradford Electric Street Railway Company, of Bradford, capitalized at $100,000, to run through the principal streets of the city of Bradford. The president is Lewis Emery, Jr., of Bradford.

DANBURY, CONN.—The Danbury and Bethel Horse Railway Company has filed with the selectmen a plan showing the highways in and through which it proposes to lay its tracks for the proposed electric railway.

COUNCIL BLUFFS, IOWA.—The Council Bluffs and Lake Manawa Electric Railway Company will build, equip and operate an electric railway from a point on South Sixth street, in the vicinity of the Rock Island depot, to the town of Manawa.

ST. JOSEPH, MICH.—We are informed by the St. Joseph and Benton Harbor Electric Railway and Light Company that its plant has not been destroyed by fire, as reported recently in these columns. We regret the error, which led to a deluge of communications from electrical firms.

LOWELL, MASS.—The work of constructing the connecting link of the Lowell, Lawrence and Haverhill Street Railway between Lowell and Lawrence has begun, and when completed the entire line from Lowell to the end will be 42 miles continuous street railway, one of the longest in the country.

UTICA, N. Y.—The Rome City Street Railway Company has for

some time had under consideration a proposition to substitute electricity for horse power. W. P. Rayland, secretary and treasurer of the company, is now engaged in securing the consent of real estate owners along the old line to the proposed change.

PHILADELPHIA, PA.—On June 15 the Philadelphia and Trenton Street Railway Company, to extend from Calhoun street bridge to Frankfort, 25 miles long, was chartered with a capital of $150,000. The incorporators are Lewis Calvin Mans, president; Theo. F. Hansen, Philadelphia; J. Bethell, Lansdowne; Jos. H. Real, Bloomfield, N. J., and J. Henry Durrale, Trenton.

OPELIKA, ALA.—The Opelika and Auburn Electric Railway Company has been organized with M. E. Gray, of Columbus, president; J. L. Cowan, Opelika, vice president and general manager; A. H. Slaughter, treasurer, and C. I. Dougherty, secretary. Preliminary surveys have been made, and the company is now in the market for the necessary construction equipment.

ELYRIA, OHIO.—Tom L. Johnson has applied to the City Council for permission to construct and operate a street railroad in this city. Mr. Johnson not only does not ask a bonus for constructing the proposed road, but proposes to pay one-third, not to exceed $3,500, toward the construction of a stone arch across the west branch of the Black River, on Lodi street.

WHITE PLAINS, N. Y.—The committee appointed by the Board of Trustees of White Plains to make a final report relative to the conditions to be imposed by the board for the granting of franchises to the New York, Elmsford and White Plains, and the New York, Mamaroneck and White Plains electric companies (railway) held a final meeting June 8, and will soon make a report.

LYNCHBURG, VA.—Owing to the sickness of members, there was no meeting of the electric road promoters in Lynchburg. The "Advance" says: "It developed, however, that if the people of the county can raise $25,000 and the right of way, the road will be built. It is understood that an effort will be made to get a vote of the county of Bedford on a subscription of $25,000."

TAMPA, FLA.—Mayor R. W. Easley and W. H. Kendrick have petitioned for the privilege of right of way for the street railway, which they are organizing a corporation to operate. They were granted the privilege of laying tracks from some point on Livingston avenue, thence south to the line of the city of Tampa, and thence along said avenue to Palm Beach and Hocker's Point.

NASHVILLE, TENN.—The Nashville Traction Company will purchase the overland Railroad Company's properties and Glendale Park from Rudolph M. Hunter, who purchased them at the recent sale. The company intends to push the improvements on the property, rebuilding the road with 60-pound steel rails, part of which have already arrived. It is expected that the road will be running within 60 days.

PITTSBURGH, PA.—A charter has been issued to a company to build an electric road from Castle Shannon to Pittsburgh. Among those interested are J. F. Grimes, of Knoxville, and W. W. Murray. The Knoxville Land Improvement Company and the Fair Haven Land Improvement Company are behind the scheme. The name of the company is the Knoxville, Fair Haven and Lebanon Railway Company, and the capital stock is $100,000.

PHILADELPHIA, PA.—A charter has been granted to the Market Street, Richmond and Frankford Street Railway Company, which has a capital of $180,000. An elevated structure will be erected, if possible, and if that cannot be done, a surface electric road will be laid, provided the necessary permission is obtained from the Council. Walter N. Boyer, treasurer of the United States Railway Supply Company, 1213 Filbert street, is president.

CHICAGO, ILL.—The Cicero and Proviso Railway Company presented a petition to the Board of Trustees of the village of Harlem, asking for permission to construct and operate a single track street railway on Harlem avenue, between the north line of the village and the centre line of West Madison street in said village. The petition was referred to a committee of the Board, and will be brought up at the next meeting of the Board, on June 23.

COHOES, N. Y.—The joint committee having charge of the arrangements for the proposed belt line electric road has met and appointed Messrs. Fruchting, Simmons, Neary, Houlihan, O'Day, Weldon, Baere and Wilcox to solicit signatures of taxpayers along the route of the proposed line for permission to operate electric cars through the streets. It was decided to name the proposed road the Cohoes City Railroad, and to make the capital stock $50,000.

SOUTH MILWAUKEE, WIS.—The residents of South Milwaukee are considering the raising of a bonus to induce the Milwaukee Street Railway to extend its line to that village. The company has already secured a franchise to extend its lines to St. Francis and Cudahy. The cost to extend it from Cudahy to South Milwaukee will be $12,000, which some residents of South Milwaukee favor raising. Work on the St. Francis and Cudahy extensions will begin shortly.

NORFOLK, CONN.—At a meeting of the Norfolk City Railway Company and the Suburban and City Railway Company, the two companies were consolidated under the name of the Norfolk Street Railroad Company, the consolidation to take effect as soon as reported to the board of public works. The following officers were elected: Murray A. Verner, of Pittsburgh, president; Thos. Clyde, of New York, vice president, and H. C. Whitehead, of Norfolk, secretary and treasurer.

TRENTON, N. J.—The North Jersey Street Railway Company, capitalized at $5,000,000, of which $40,000 is paid in, filed its certificates of incorporation with the Secretary of State on June 14. The incorporators are James K. Corbiere, of Caldwell; Daniel V. Harrison and William H. Power, of Montclair; James C. Beach and Halsey M. Barrett, of Bloomfield; William J. Davis, Harrison; Henry M. Doremus, of Newark, and John L. Johnson, of Verona. The company will operate in Newark.

NIAGARA FALLS, N. Y.—A franchise for the Niagara Falls, Whirlpool and Northern Electric Railroad, running from the northern part of the city down Main street to the Devil's Hole, was secured from the Common Council two or three months ago, and now the contract for the construction of the road has been let to J. W. Hoffman & Co., of Philadelphia. The ties have begun to arrive, and the work will begin at once. It is expected that the road will be in operation by Aug. 1. The power will be obtained of the Niagara Falls and Suspension Bridge Street Railroad Company, with which company traffic arrangements will probably be made.

MORRISTOWN, N. J.—A communication signed by Aug. W. Cutler, attorney, representing some citizens of Morristown, states that they are about to perfect the incorporation of a street railway in Morristown, to be run by horse, steam or electricity, and that they are at work securing the consent of the property owners before petitioning the Council for the franchise. The communication further states that the company would be willing to pay the city for the franchise, say 2 per cent. of the gross or 5 per cent. of the net earnings of the road. Referred to committee on streets.

Miscellaneous Notes.

THE WESTERN UNIVERSITY OF PENNSYLVANIA, Allegheny, Pa., reports that with its large faculty and thoroughly equipped laboratories it is now as well prepared to meet the requirements of those seeking an education, especially in engineering, as almost any other college in the country.

THE NEW YORK ELECTRIC CLUB.—A proposition has been made by a number of the former members of the New York Electric Club to have an annual dinner in memory of the club. The first dinner will be held at the Imperial Hotel on June 21. Those desiring to attend should communicate with Mr. George F. Porter, 136 Liberty street, not later than June 18.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION will hold its fourth annual meeting at the New York Academy of Medicine, 17, 19 and 21 West 43d street, New York City, on Tuesday, Wednesday and Thursday, Sept. 25, 26 and 27, 1894. The sessions are to be held in the main hall on the ground floor, and the room immediately adjoining has been secured for the exhibition of electro-medical apparatus.

THE POSTAL TELEGRAPH BUILDING, 253 Broadway, was, on the invitation of President Chandler, visited on Monday night of this week by representatives of the electrical manufacturing and supply industries of New York and vicinity; on Tuesday evening by the members, in a body, of the New York Electrical Society, and later in the week by the members of the American Institute of Electrical Engineers, and many other distinguished guests, who examined with much interest the electrical plant and other features of the handsome building. The offices of The Electrical World were kept open on each of the evenings for the benefit of the visitors, many of whom honored it with a call.

LONG ISLAND ELECTRIC RAILWAYS.—A new railroad syndicate has been formed to construct an extensive system of electric railways on Long Island, which, it is thought, will compete with Corbin's Long Island Railroad for a greater part of the lucrative traffic now enjoyed by the latter. The first line will soon be constructed from the Brooklyn city boundary to Jamaica, whence a spur will run to Far Rockaway, and along the beach to Rockaway. The main line will run parallel with the tracks of the Long Island Railroad through a half-score towns to Babylon. From Rockville Centre branches will run north and south, the former to Mineola and the latter to Long Beach. It is the intention to eventually build to Patchogue.

Trade and Industrial Notes.

THE ST. LOUIS ELECTRICAL SUPPLY COMPANY has secured the contract for the 500-light incandescent plant at New Athens.

THE GENERAL ELECTRIC COMPANY'S Washington office will be transferred to 227 East German street, Baltimore, Md., on the 21st inst.

THE BLAIR LAMP ADJUSTER COMPANY, of Omaha, Neb., reports good success with its adjuster, and at present is working day and night in order to keep its stock up to the demand.

THE GENERAL ELECTRIC LAUNCH COMPANY has sold Mr. Henry W. Parsell a new and handsome electric launch for use on Schroon Lake during the coming summer. The launch is equipped with batteries of the Consolidated Electric Storage Company.

THE H. W. JOHNS COMPANY, 87 Maiden lane, New York, has the contract from the Bridgeport (Conn.) Traction Company for furnishing all trolley line insulators, and a similar contract with the Poughkeepsie (N. Y.) and Wappinger Falls Railway Company.

THE NATIONAL WATER-TUBE BOILER COMPANY, New Brunswick, N. J., gives a concise resume, in a small pamphlet, of the advantages of water-tube boilers over those of the fire-flue or fire-tube type, and calls attention to the superior rating received by its boilers at the World's Fair over other water-tube types there used.

MASON'S ELECTRIC EXCHANGE, 943 Fulton street, Brooklyn, has issued an illustrated circular describing the Mason perfected phonograph battery. All of the phonographs (nearly 100 in number) at Coney Island, Manhattan Beach and Eldorado last summer were successfully operated the entire season by this battery.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., will build the roof of the new electric light station for the Flatbush Gas Company, at Flatbush, N. Y., which will be 60 feet wide and 73 feet long, divided into a dynamo room and a boiler house. The roof will be covered with its patent anti-condensation corrugated iron roof covering.

MR. ALTON D. ADAMS, Worcester, Mass., has entered the field as consulting electrical engineer in addition to his other connections, and will make the design of electric machinery, power transmission and street railway plants a specialty. Mr. Adams' success as a designer of electric machinery and wide experience in general electrical engineering indicate his fitness for this work.

THE SIMPLEX ELECTRICAL COMPANY, 1137 and 1138 Monadnock Block, Chicago, announces that the relations heretofore existing, by which Mr. George Cutter has been acting as its Western sales agent, have been dissolved. Its Chicago office will hereafter be located at 1137 and 1138 Monadnock Block, and Mr. H. R. Hixson, who has for some time been identified with its interests in Chicago, will be in charge.

THE COLUMBIA ELECTRIC COMPANY, Worcester, Mass., has recently bought out the stock and trade of the Worcester Electrical Engineering Construction Company, and is carrying on, together with the manufacturing of dynamos, a construction and supply trade. Its offices are located in the Burnside Building, 339 Main street, Worcester, and the factory at 180 Union street.

THE JOHNS-PRATT COMPANY, for whom the H. W. Johns Manufacturing Company, 87 Maiden lane, New York, is the selling agent, is pushing the delivery of trolley line insulating materials for 43 miles of road recently contracted for by the Hartford Street Railway Company. The Johns-Pratt Company also manufactures vulcabeston, "Monarch" and other insulating materials.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., describes in a small pamphlet its 1894 model fan motors, which are adapted for both direct and alternating currents. These new models embody all the improvements which three years' of manufacture and service have suggested, and are guaranteed to run three months without any repairs whatever. The pamphlet also illustrates the transformers manufactured by this same firm.

THE CLONBROCK STEAM BOILER WORKS, Brooklyn, N. Y., closed the following contracts for Climax boilers last week: United Electric Light and Power Company, New York City, 10,000 h. p.; Thomson-Houston Electric Company, New York City, 1,000 h. p.; New Electric Light and Power Company, Newark, N. J., 2,000 h. p.; Central Railway and Electric Company, New Britain, Conn., 1,000 h. p.; Edison Electric Illuminating Company, Brooklyn, 4,000 h. p.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, 620 Atlantic avenue, Boston, Mass., received its patent on its telephone on May 29. As the application was filed on March 24, this is remarkably quick work on the part of the patent office. This telephone which was illustrated and described in The Electrical World of Jan. 27 and April 14, 1894, has already attracted much attention. The company also manufacture an improved transmitter. A modern magneto bell will soon be placed on the market by the company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., on account of the demand for the Packard "Mogul" lamp for outside work, has made arrangements for a special street hood for the Mogul lamp, and will place it on the market shortly. The company has also made arrangements with the principal supply dealers throughout the country for handling the Allyn soldering stick; a single day's shipment last week ran up to over 5,000 sticks, and was made up chiefly of small orders.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., sends us a folder containing a large number of testimonials to the efficiency of the Commercial dynamos and motors. One from the well known Chas. E. Gregory Company, of Chicago, states that a 15-kw. Commercial dynamo it installed ran 22 hours daily from May 1 to Nov. 3, 1893, without any shut down or interruption whatever, and with a wear on the commutator during that period which did not exceed 1-64th of an inch.

THE INDEPENDENT ELECTRIC COMPANY, 39th street and Stewart avenue, Chicago, Ill., has issued a neat 24-page pamplet relating to the exhaustive line of tested fuse wire and links made by it. An excellent technical article on fuse links, by its electrical engineer, Chas. A. Pratt, is included, which is the best treatise on the subject that we know of, both from a practical and theoretical standpoint, and should be read by every electric light and power station superintendent.

BURTON L. WHITE, electrician for the McCullough-White Electrical Supply Company, of Witchita, Kan., has severed his connection with that firm, and has opened up an office for himself at 1423 North Lawrence avenue, in the same city, where he will be pleased to furnish estimates on fire alarm, telephone, lighting and annunciator systems free. Mr. White was in the employ of the Electric Launch and Navigation Company as charging electrician during the World's Fair. We wish him success in his new venture.

MESSRS. CHAS. SCHIEREN & CO. shipped to the Bangkok Tramway Company, Ltd., Bangkok, Siam, last fall, two 14-inch perforated leather belts. Upon arrival they were immediately placed on Brush generators. In a letter from the manager of the road to the Brush company in January last, the following statement is made: "Belting is also running, and has so far given us extreme satisfaction; our chief engineer can, in fact, scarcely find terms to express his admiration for its fine appearance and smooth running."

MESSRS. STUCKY & HECK, 23 and 25 N. J. R. R. avenue, Newark, N. J., report their repair and supply business exceptionally good. The electrical apparatus of the steamers Carib Prince and Irrawaddy has been entirely overhauled by them, and is again ready for service. They have recently acquired the agency for the Fleming woven wire dynamo brush for Newark, Paterson, Jersey City and surrounding district, and many orders have already been taken. Messrs. Stucky & Heck pay particular attention to commutator repairs and rewinding of armatures.

THE SHULTZ BELTING COMPANY, St. Louis, Mo., has issued a neat circular calling attention to its patent grooved sable rawhide belting. This belting is tanned only on the surfaces, instead of all the way through, thus preserving an interior of rawhide of great strength and durability, and affording a soft driving surface. The grooves run lengthwise of the belt, thus offering channels for the escape of air, so as to avoid air cushions. The grooves are constantly kept clean by the currents of air. They can be run, it is claimed, very nearly as slack as link belting.

G. M. ANGIER & CO., 116 Bedford street, Boston, Mass., who are exclusive contractors for apparatus manufactured by the Mather Electric Company in New England, have just closed a contract with the Gardner Electric Street Railway Company, of Gardner, Mass., for one 160-h. p. Mather multipolar generator. Messrs. Angier & Co. are devoting a great deal of attention to the equipment of street railway plants, and, as the Mather generator in its present form has all the latest improvements and a very high efficiency, we bespeak for them a good business during the present season.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., has brought out a handsome catalogue, giving a short description of its improved ring type lighting dynamo, with dimensions of the different sizes now manufactured, and a partial list of plants in operation. This pamphlet is supplementary to the very complete one covering the Mather company's system of incandescent lighting and an addition to its special catalogues, of which it is the fourth, the others being on "Slow Speed Electric Motors," "Street Railway Generators and Equipments" and "Direct Connected Lighting and Power Generators."

QUEEN & CO., Philadelphia, report that their Acme testing set is meeting with a continually increasing success. Its compactness and lightness are much greater than the sets previously designed by this firm, it being contained in a box 8 inches by 6 inches by 5 inches, and weighing but 6 pounds. The quickness with which resistance measurements can be made with it renders it especially popular with electric light and railway companies, dynamo and motor manufacturers, inspectors, etc. A specially valuable feature is the ability to use it anywhere, even in the closest proximity to large dynamos.

THE ROYAL ELECTRIC COMPANY, Peoria, Ill., has issued a pamphlet giving short, concise descriptions of the apparatus manufactured by it, accompanied by tables of full electrical and other data. The well known alternating dynamo of this firm, we learn, is manufactured in capacities from 500 to 2,000 lights, the speed varying from 1,100 to 700 revolutions. With alternating machines a slate switchboard is furnished, equipped with all necessary apparatus, which is a commendable feature. The Royal direct current machines and Royal transformers are also illustrated, and tables of data relating to them given.

THE MICA INSULATOR COMPANY, 218 Water street, New York, in a 24-page catalogue just issued, describes and illustrates the various micanite products made by it, and includes some 10 pages of unusually cordial testimonials as to their merits. As an example, we reprint the following from the United Columbian Electric Company: "We have given your micanite and micanite cloth a severe trial, and are satisfied it comes as near to being a perfect insulator as anything can. The micanite troughs, for slotted armatures, are far superior to anything we have yet seen. We have seen an armature, built for 500-volt railway circuit, insulated throughout with micanite, stand a 2,000-volt current without breaking down."

THE UNITED STATES HEAD-LIGHT COMPANY, Utica, N. Y., of which J. Kirby, Jr., is president and A. J. Williams secretary, has purchased of M. M. Buck & Co., the Dayton Manufacturing Company, the Kelly Lamp Company, I. A. Williams & Co., and the Adams & Westlake Company the machinery, tools, patterns, etc., constituting their head-light business, together with 32 letters patent and a number of applications for patents, covering standard

devices for illuminated numbers and signals in head-lights and other desirable improvements therein. It is the intention of the United States Head-Light Company to unite with the patents and facilities thus acquired the result of over forty years' experience in manufacturing head-lights, for the purpose of embodying in them the latest improved devices which will add to their design, convenience and durability; furnishing head-lights for all purposes superior to any heretofore supplied, at the lowest possible price consistent with first-class material and workmanship. Selling agents for this company will be conveniently located in the best distributing points of the country, who will carry in stock a full line of standard head-lights and parts thereof, for the purpose of filling all orders promptly.

THE STANDARD ELECTRIC COMPANY, Chicago, has just published a handsome catalogue of 88 7½ by 10½ inch pages, descriptive of the Standard system of dynamo-electric machinery. The book is bound in cardboard covers, and is well printed on a fine, heavy paper, with numerous exceptionally well executed half-tones. The great success which attended the introduction of the Standard series arc system encouraged the belief that the principles of construction therein involved would also be appreciated in further applications, and a year or more has been devoted to designing and perfecting a complete line of apparatus for all purposes, and the formal presentation of Standard apparatus for arc, alternating and direct current work is made in this catalogue. In addition to dynamos and motors, the company has also perfected, on entirely new lines, a complete complement of accessories, such as instruments, switches, transformers, etc., which are also fully illustrated therein. The more important apparatus have been recently illustrated and described in our columns, but every central station manager and electrical contractor will find it to his interest to procure a copy of the catalogue in order to obtain a full presentation of a system which is complete in all of its details, and bears evidence of skillful design and thorough construction.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden Carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED JUNE 5, 1894.

In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

520,763. MULTIPHASE CURRENT MOTOR; L. Bell, Boston, Mass. Application filed Nov. 4, 1892. This comprises a field magnet having a row of poles in a continuous ring, a winding thereon by which continuous current is passed around the field magnet poles, an independent closed-circuited winding in grooves in the pole faces, and a switch adapted to open or close the closed circuited winding. (See illustration.)

520,764. METHOD OF, AND MEANS FOR, STARTING ALTERNATING CURRENT MOTORS; L. Bell, Boston, Mass. Application filed July 3, 1893. This consists in arranging the inducing coils of the motor in multiple at starting, and when the speed rises, throwing the coils into series.

520,772. FUSE BOX; A Ekstrom, Lynn, Mass. Application filed Nov. 29,1892. This comprises a box, line terminal supports ranged on each side thereof, leaving a space between them, and a fuse supporting block adapted to slide in between the supports and fill the space between them.

520,773. ARMATURE FOR DYNAMO ELECTRIC MACHINES; H. F. T. Erben, Schenectady, N. Y. Application filed Feb. 9, 1894. The combination of a spider having arms adapted to engage core discs, the arms being provided with an opening, and conductors passing through such opening, and commutator segments connected to such conductors.

520,776. LIGHTNING ARRESTER; J. W. Gibboney, Lynn, Mass. Application filed Feb. 6, 1893. This comprises an electric generator and work circuit supplied therefrom, and a constantly maintained short circuit composed of liquid flowing from one main line conductor to the other.

520,780. ELECTRIC MOTOR TRUCK; J. C. Henry, Westfield, N. J. Application filed Aug. 27, 1892. This comprises an electtromagnet, a receptacle surrounding the same, a pipe communicating at each end with the top and bottom of the receptacle, respectively, and forming a closed circuit therewith, and a fluid insulant filling the receptacle and pipe. (See illustration.)

520,781. DYNAMO ELECTRIC MACHINE; A. B. Herrick, Schenectady, N. Y. Application filed Jan. 25, 1894. This consists in rotating the armature in a composite field of force having some of its parts more highly magnetized than others.

520,782. ELECTRIC MOTOR; A. Hinman, Olympia, Wash. Application filed Dec. 14, 1893. A motor having its armature coils held within seatings by metallic washers, whereby one or more may be removed by loosening the screw of the washer.

520,784. ELECTRIC MOTOR CONTROLLER; W. J. Hopkins and T. Stebbins, Boston, Mass. Application filed Sept. 19, 1891. A controller having a movable contact arm, a removable actuator engaging therewith, and a detent adapted to lock the contact arm when the actuator is removed.

520,786. EAR PAD FOR TELEPHONE RECEIVERS; J. W. Kinniburgh, Wellington, New Zealand. Application filed Nov. 10, 1893. A pad formed of layers of material joined together in such manner that a clean surface is exposed when desired.

520,787. ELECTRIC LOCOMOTIVE; W. H. Knight, Lynn, Mass. Application filed Jan. 18, 1894. The combination of two or more trucks, each having a plurality of separately driven axles mechanically connected together, and means for simultaneously effecting the same change in the motive condition of each truck.

520,788. STAND FOR CONTROLLING ELECTRIC CIRCUITS; E. R. Knowles, Middletown, Conn., and E. H. Park, Millbury, Mass. Application filed March 31, 1893. The combination with a stationary insulating plate carrying spring pins, of a movable box containing the insulating plate carrying rigid pins.

520,789. VOLTMETER; E. R. Knowles, Middletown, Conn. Application filed Dec. 5, 1893. The combination with an armature, of a spindle on which it is mounted, and a copper shell surrounding the spindle and having bearings in which the spindle is journaled.

520,795. ELECTRO-PROTECTIVE SYSTEM FOR LOCKS; M. Martin, Malden, Mass. Application filed Nov. 23, 1893. The combination with a lock provided with a removable cover, and a locking device for the cover under the control of the key for the lock.

520,800. ALTERNATING CURRENT MOTOR; O. Offrell, Middletown, Conn. Application filed Nov. 29, 1892. A motor comprising end frames having planes to fit against the field magnet core, and dished portions to inclose the field magnet coils.

520,809. MEANS FOR PREVENTING ARCING IN ELECTRIC POWER STATIONS; E. Thomson, Swampscott, Mass. Application filed Sept. 1, 1890. The combination with a circuit breaking apparatus of a wall on one side thereof, and provided with an opening in proximity thereto, and arc propelling means for forcing toward the opening any arc that may form at the circuit breaking apparatus.

520,810. ELECTRIC RECIPROCATING MOTOR; E. Thomson, Swampscott, Mass. Application filed July 10, 1891. The combination in a reciprocating electric motor, of a reciprocating rod, an armature sleeved thereon, stops on the rod, and buffers between the armatures and stops.

520,811. ELECTRIC METER; E. Thomson, Swampscott, Mass. Application filed Feb. 21, 1894. This comprises a series coil, an armature, a resistance in series with the armature, and a shunt coil arranged to furnish an initial or starting field sufficient to balance the friction of the moving parts, such coil being in series with a resistance.

520,820. SIGNAL LIGHT FIXTURE; W. Carter, J. W. Dawson and J. Meyrick, Jr., Louisville, Ky. Application filed April 5, 1893. This comprises a valve seat, a gravity valve therein, a channel between the seat and the valve, and an electromagnet supported with its poles in convenient proximity to the valve.

520,822. SYSTEM OF CIRCUIT CONTROL FOR ELECTRIC MACHINES; C. E. Davis, Chicago, Ill. Application filed Oct. 16, 1893. This consists in breaking the supply circuit, connecting the motors in series with each other and closing a short circuiting device around one of the motors.

520,852. ELECTRIC SWITCH BOX; E. R. Knowles, Middletown, Conn. Application filed Dec. 5, 1893. This comprises a double pole snap switch inclosed in a watertight box, and having an operating handle on the outside of the box.

520,855. FEED WIRE INSULATOR; C. A. Lieb, New York, N. Y. Application filed April 12, 1894. An insulator composed of a body of insulating material, and a metal cap therefor carrying a sleeve having a curved bottom for the feed wire.

520,895. WOMB BATTERY; J. C. Petit, Fort Worth, Tex. Application filed April 10, 1894. This comprises a body having a hollow shank, and a hollow stem connected to the shank, and made of electrically dissimilar material from the body, and an adjusting instrument having a hook at one end.

520,908. ELECTRIC CIRCUIT REGULATOR; H. F. Waite, New York, N. Y. Application filed Jan. 27, 1893. This comprises a motor, a circuit breaker, current connections, and a governing device controlling the circuit, whereby when the interruptions fall below a certain number, the circuit will be interrupted.

520,926. LEVER CONTROLLING DEVICE; A. H. Johnson, Rahway, N. J. Application filed Sept. 6, 1893. This comprises a lever and a movable dog for locking it, a current including a magnet for attracting the dog, a device for positively moving the magnet toward the dog when the latter is in locking position, and a weight for effecting this movement.

520,937. TROLLEY WIRE SUPPORT; L. McCarthy, Boston, Mass. Application filed March 3, 1894. This comprises a supporting arm, an insulator and jointed connectors extending upwardly

and in opposite directions from the insulator and suspending it below the points of attachment of the connectors.

520,938. CLOSED CONDUIT FOR ELECTRIC RAILWAYS; P. Plodeck, Sr., Cleveland, Ohio. Application filed Feb. 21, 1894. This consists of an underground conduit covered by a row of lids which are lifted by the passing of the trolley arm of the car.

520,940. DYNAMO ELECTRIC MACHINERY; C. Sellers, Philadelphia, Pa. Application filed Oct. 27, 1893. In a dynamo electric machine having a vertical shaft, a cylindrical frame provided with internal projections having bearings concentric with the axis of the rotation of the shaft. (See illustration.)

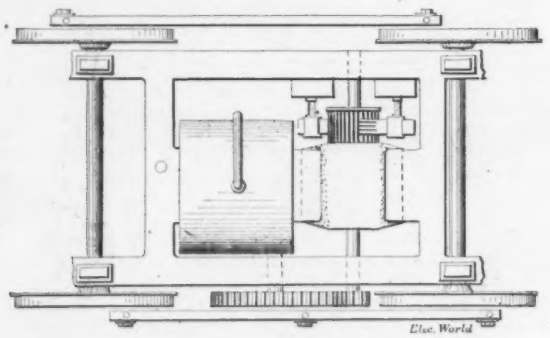
520,963. AMMETER; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. An ammeter having its helix composed of a strip of metal containing two narrow and wider portions, one following the other.

520,964. VOLTMETER; E. R. Knowles, Middletown, Conn. Application filed Dec. 14, 1893. This comprises a core containing a narrow transverse socket, in combination with a flat frame removably inserted in the socket and containing bearings for the needle spindle.

520,965. SYSTEM OF ELECTRICAL DISTRIBUTION; B. G. Lamme, Pittsburgh, Pa. Application filed March 27, 1893. A constant current alternating generator, a series motor in the circuit thereof, a constant current series direct current generator, and translating devices in series with the direct current generator.

520,970. METHOD OF ECONOMIZING THE ENERGY OF ALTERNATING CURRENTS; C. F. Scott, Pittsburgh, Pa. Application filed Aug. 7, 1893. This comprises a feeding converter, translating devices in the secondary thereof, an auxiliary converter having its primary and secondary in series respectively with the primary and secondary of the main converter, and means whereby said auxiliary converter may be short circuited.

520,971. ELECTRIC RAILWAY OVERHEAD SWITCH; M. A. Smith, Brooklyn, and W. Clabaugh, New York, N. Y. Application filed Feb. 21, 1894. This comprises a rib having a horizontal contact portion, and inclined groove, and a split key clamp at the outer end of the groove.



NO. 520,780.—ELECTRIC MOTOR TRUCK.

520,975. CONVERTER SYSTEM FOR ELECTRIC RAILWAYS; G. Westinghouse, Jr., and C. F. Scott, Pittsburgh, Pa. Application filed July 31, 1893. This comprises a working conductor, an alternating current generator and main line fed therefrom; in combination with one or more converters, the primaries of which are fed by the main line, and the secondaries of which are connected to the working conductor, means for resisting flow of current in series with the primaries of the converters, and means actuated by the increase of current due to closing the secondary circuit through the car motors for short circuiting the current resisting means.

520,991. ELECTRIC ARC LAMP; L. E. Howard, Plainfield, N. J. Application filed Aug. 19, 1893. A lamp having its burner or source of light surrounded by a transparent envelope coated with a deposit of translucent metallic oxide.

520,996. ELECTRIC ARC LAMP; L. B. Marks, New York, N. Y., and C. Ransom, Passaic, N. J. Application filed Jan. 9, 1894. This consists in confining the arc within an inclosure, restricting all the drop of potential in the arc circuit to the arc, and continuously maintaining the drop at a point which prevents an excessive flow of current.

521,010. CONDUIT ELECTRIC RAILWAY SYSTEM; J. B. Brand, Milwaukee, Wis. Application filed March 19, 1894. This comprises a closed conduit pipe, a plurality of contact devices movably engaged within bearings in the wall of the pipe, a conductor extending through the pipe adapted to make contact with the contact devices, and a service rail comprising a plurality of sections flexibly engaged with and insulated from each other at the joint and pivotally connected at the joint with the contact devices.

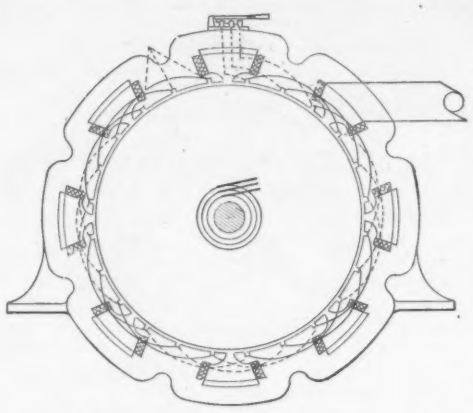
521,018. CONNECTION FOR ELECTRIC WIRES; J. Y. De Mott, Newark, N. J. Application filed Jan. 6, 1894. This comprises a plate of conductive material bent at the centre to form a raised rib and having its opposite edges turned on to the rib and forming a joint thereat.

521,046. ELECTRICAL ANNUNCIATOR; F. W. Ross, Boston, Mass. Application filed Jan. 12, 1894. This comprises a single helix having a sliding armature core, a device for holding the core normally beyond the helix, an unequally balanced lever adapted to be tripped by the core, a sleeve outside of the helix, and an index finger carried on the end of the spindle.

521,051. SYSTEM OF ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS; C. F. Scott, Pittsburgh, Pa. Application filed Feb. 26, 1894. This consists in transmitting three-phase alternating currents to a distance, transforming the same into two-phase alternating currents, and utilizing the transformer currents.

521,089. ELECTRIC METER; W. B. Reed, New Orleans, La. Application filed Feb. 13, 1894. In a three-wire system of electric lighting, the combination with an electric meter, of an electric motor having a rotating armature and field coils, the latter being supplied from the positive and negative sides of the system, respectively, and an armature circuit fed normally from the neutral wire which enters the meter.

521,099. ELECTRIC HEATING APPARATUS; G. D. Burton, Boston, Mass. Application filed Aug. 11, 1893. This comprises a converter attached to one terminal of a converter and provided with means for receiving one end of the rod to be heated, and an arc shaped conductor attached to the other terminal of the



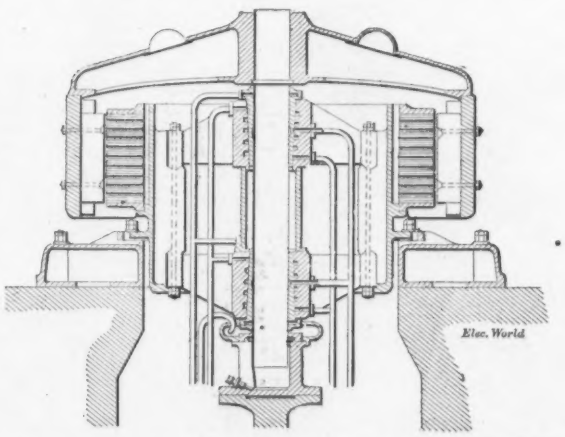
NO. 520,763.—MULTIPHASE CURRENT MOTOR.

converter and adapted to swing away from and toward the central hub, the conductor being provided with a series of undercut tapering jaws.

521,124. SECTION INSULATOR; H. B. Nichols and F. H. Lincoln, Philadelphia, Pa. Application filed Jan. 25, 1894. This comprises an insulating block or strip of fibre, contact arms engaging the ends thereof, and a bridge wire connecting the arms.

521,125. ELECTRIC SUBWAY; J. J. E. Philips, Brooklyn, N. Y. Application filed Aug. 29, 1893. A carriage for laying a cable in a conduit, consisting of a series of cars, trolleys, detachable connections uniting them, and laterally slotted supports carried thereby.

521,131. INCANDESCENT LAMP; D. C. Voss, Boston, Mass. Application filed Nov. 23, 1893. An insulating cement free of silica, potash, soda and lime, and composed of the oxides of lead, manganese and alumina of highest oxidation combined by fusion with each other.



NO. 520,940.—DYNAMO ELECTRIC MACHINERY.

521,138. ELECTRIC MOTOR FOR DENTAL ENGINES; W. A. Crowdus, Chicago, Ill. Application filed Oct. 22, 1892. The combination of an electric motor, and a brake located within the magnetic influence of the motor and actuated thereby.

521,144. ANNUNCIATOR; T. J. Thompson, Chicago, Ill. Application filed Sept. 30, 1891. This comprises a single spool of a core provided with projecting ends forming pole pieces, adjustable screws inserted in the under faces of the poles, an armature loosely mounted thereon and provided with a notch, a latch rigidly mounted upon the same shaft with the pointer, and a stud forming the bearing of the shaft, the shaft being cut away to permit the latch and permit the rotation thereof.